भारतीय मानक
Indian Standard

IS 3028 (Part 2) : 2023

स्वचल वाहन — चलती वाहनों द्वारा शोर का उत्सर्जन—विशिष्टि एवं मापन पद्धति

भाग 2 एल 2 एवं एल 5 श्रेणी के अलावा

Automotive Vehicles — Noise Emitted by Moving Vehicles — Specification and Method of Measurement

Part 2 Other than L 2 and L 5 Category

ICS 17.140.30

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April 2023 **Price Group 15**

Automotive Braking and Steering Systems, Vehicles Testing and Performance Evaluation Sectional Committee, TED 04

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Automotive Braking and Steering Systems, Vehicles Testing and Performance Evaluation Sectional Committee had been approved by the Transport Engineering Division Council.

The requirements of noise emitted by moving vehicles were earlier covered in IS 3028 : 1998 ‘Automotive Vehicles — Noise Emitted by Moving Vehicles — Method of Measurement (*second revision*)’.

While reviewing this standard the committee responsible for the formulation of this standard has decided to revise the standard based on latest ECE regulations. As ECE regulations are different for two wheelers, three wheelers and other M & N category of vehicles. It was also decided to split this standard into three different parts.

While this Part 2 covers ‘Noise emitted by vehicles other than L2 and L5 category’, the other parts in this series are:

Part 1	L2 category
Part 3	L5 category

While formulating the standard reference is drawn from UNR 51 :ECE/TRANS/505/Rev.1/Add.50/Rev.3/ Amend 1, Amend 2, Amend 3, Amend 4, Amend 5 and Amend 6.

The stationary noise emitted by vehicles is covered separately by IS 10399 : 2022 ‘Automotive vehicles — Noise emitted by stationary vehicles — Method of measurement (*second revision*)’.

The composition of the committee responsible for preparation of this standard is listed in Annex H.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off va.lue should be the same as that of the specified value in this standard.

Indian Standard

AUTOMOTIVE VEHICLES — NOISE EMITTED BY MOVING VEHICLES — SPECIFICATION AND METHOD OF MEASUREMENT

PART 2 OTHER THAN L2 AND L5 CATEGORY

1 SCOPE

This standard specifies the method for measuring the exterior noise emitted by motor vehicles of categories M and N as defined in IS 14272 in moving condition.

The specifications in this standard are intended to reproduce the sound levels which are generated by vehicles during normal driving in urban traffic.

This standard provides, as well, additional sound emission provisions for vehicles of categories M1 and N1 referring to driving conditions with extreme accelerations in an extended speed range representative for urban and suburban traffic.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

IS No./Other Publication	*Title*
IS 14272 : 2011	Automotive vehicles — Types — Terminology (*first revision*)
IS 14599 : 1999	Automotive vehicles — Performance requirements (measurement of power, SFC, opacity) of positive and compression ignition engines — Method of test
ISO 362-3 : 2016	Measurement of noise emitted by accelerating road vehicles — Engineering method: Part 3 Indoor testing M and N categories
ISO 612 : 1978	Road vehicles — Dimensions of motor vehicles and towed vehicles — Terms and definitions
ISO 10844 : 2014	Acoustics — Specification of test tracks for measuring noise emitted by road vehicles and their tyres
IEC 60942 : 2017	Electroacoustics — Sound calibrators
IEC 61672-1 : 2002	Electroacoustics — Sound level meters: Part 1 Specifications
IEC 61672-3 : 2013	Electroacoustics — Sound level meters: Part 3 Periodic tests

3 DEFINITIONS

For the purpose of this standard following definitions shall apply:

3.1 Approval of a Vehicle

The approval of a vehicle type with regard to sound.

3.2 Vehicle Type

A category of motor vehicles which do not differ in such essential respects as:

3.2.1 For vehicles tested according to **B-3.1.2.1**:

a) The shape or materials of the engine compartment and its sound proofing;

b) The type of engine (positive or compression ignition, two- or four-stroke, reciprocating or rotary piston), number and capacity of cylinders, number and type of carburetors or injection system, arrangement of valves, or the type of electric motor;

c) Rated maximum net power and corresponding rated engine speed(s); however if the rated maximum net power and the corresponding rated engine speed differs only due to different engine mappings, these vehicles may be regarded as from the same type; and

d) The silencing system.

3.2.2 For vehicles tested according to **B-3.1.2.2**:

a) The shape or materials of the engine compartment and its sound proofing;

b) The type of engine (positive or compression ignition, two- or four-stroke, reciprocating or rotary piston), number and capacity of cylinders, type of injection system, arrangement of valves, rated engine speed (S), or the type of electric motor; and

c) Vehicles having the same type of engine and/or different overall gear ratios may be regarded as vehicles of the same type.

3.3 However, if the differences in **3.2.2** provide for different target conditions, as described in **B-3.1.2.2**, these differences are to be considered as a change of type.

3.4 Mass of a Vehicle in Running Order (m_{ro})

In the case of a motor vehicle, it is the mass of the vehicle, with its fuel tank(s) filled to at least 90 percent of its or their capacity/ies, including the mass of the driver, of the fuel and liquids, fitted with the standard equipment in accordance with the manufacturer's specifications and, when they are fitted, the mass of the body work, the cabin, the coupling and the spare wheel(s) as well as the tools. In the case of a trailer, it is the mass of the vehicle including the fuel and liquids, fitted with the standard equipment in accordance with the manufacturer's specifications, and, when they are fitted, the mass of the body work, additional coupling(s), the spare wheel(s) and the tools.

3.5 Technically Permissible Maximum Laden Mass (M)

The maximum mass allocated to a vehicle on the basis of its construction features and its design performances; the technically permissible laden mass of a trailer or of a semi-trailer includes the static mass transferred to the towing vehicle when coupled.

3.6 Vehicle Length

A dimension which is measured according to ISO standard 612-1978, term No. 6.1. In addition to the provisions of that standard, when measuring the vehicle structural length the following devices shall not be taken into account:

a) Wiper and washer devices;
b) Front or rear marker-plates;
c) Customs sealing devices and their protection;
d) Devices for securing the tarpaulin and their protection;
e) Lighting equipment;
f) Rear view mirrors;
g) Rear space watching aids;
h) Air-intake pipes;
j) Length stops for demountable bodies;
k) Access steps;
m) Ram rubbers;
n) Lifting platforms, access ramps and similar equipment in running order, not exceeding 200 mm, provided that the loading capacity of the vehicle is not increased; and
p) Coupling devices for motor vehicles.

3.7 Vehicle Width

A dimension which is measured according to ISO standard 612-1978, term No. 6.2. In addition to the provisions of that standard, when measuring the vehicle structural width the following devices shall not be taken into account:

a) Customs sealing devices and their protection;
b) Devices for securing the tarpaulin and their protection;
c) Tyre failure tell-tale devices;
d) Protruding flexible parts of a spray-suppression system; and
e) Lighting equipment.

3.8 Rated Maximum Net Power (P_n)

The engine power expressed in kW and measured by the method as per IS 14599.

3.8.1 If two or more sources of propulsive power operate at the conditions of test specified in Annex B to this Standard, the total engine power, P_n shall be the arithmetic sum of parallel propulsive engines on the vehicle.

Applicable parallel propulsive engines are those power sources, which provide forward motion to the vehicle in combination at the conditions of test, specified in Annex B. The specified power for non-combustion engines shall be the power stated by the vehicle manufacturer.

3.9 Rated Engine Speed (S)

The declared engine speed in rpm at which the engine develops its rated maximum net power pursuant to IS 14599 or, where the rated maximum net power is reached at several engine speeds, the highest one of those speeds.

3.10 Power to Mass Ratio Index (PMR)

A numerical quantity (*see* **B-3.1.2.1.1**) with no dimension used for the calculation of acceleration.

3.11 Reference Point

Reference point is one of the following points:

a) In the case of vehicles of categories M1, N1 and M2 < 3 500 kg technically permissible maximum laden mass:

   1) For front engine vehicles: the front end of the vehicle;
   2) For mid-engine vehicles: the centre of the vehicle; and
   3) For rear engine vehicles: the rear end of the vehicle.

   For vehicles having multiple propulsion sources, the reference point is determined by the position of the propulsion source having the highest power. If there are multiple propulsion sources of equivalent power, then the position of the most forward propulsion source shall prevail.

b) In the case of vehicles of categories M2 > 3 500 kg technical permissible maximum laden mass, M3, N2, N3:

   1) For front-engine vehicles, the front end of the vehicle; and
   2) For all other vehicles, the border of the engine closest to the front of the vehicle;

3.12 Engine

The power source without detachable accessories.

NOTE — Power source includes in this context all sources of motive power; for example, electric or hydraulic power sources used alone or in combination with other power sources.

3.13 Target Acceleration

Acceleration at a partial throttle condition in urban traffic and is derived from statistical investigations.

3.14 Reference Acceleration

The required acceleration during the acceleration test on the test track.

3.15 Gear Ratio Weighting Factor *(k)*

A dimensionless numerical quantity used to combine the test results of two gear ratios for the acceleration test and the constant speed test.

3.16 Partial Power Factor (k_P)

A numerical quantity with no dimension used for the weighted combination of the test results of the acceleration test and the constant speed test for vehicles.

3.17 Pre-acceleration

Application of acceleration control device prior to *AA'* for the purpose of achieving stable acceleration between *AA'* and *BB'* as referred to in Fig. 1 of Annex B.

3.18 Gear

3.18.1 *Gear Ratios*

3.18.1.1 *Internal gearbox ratio*

The ratios of engine to gearbox output shaft revolutions.

3.18.1.2 *Final drive ratio*

The ratio(s) of gearbox output shaft to driven wheel revolutions.

3.18.1.3 *Total gear ratio*

The ratios between vehicle speed and engine speed during the passage of the vehicle through the test track.

3.18.1.4 *Gear ratio*

Used in context with vehicles tested according to **B-3.1.2.1** and Annex D is the total gear ratio as defined in **3.18.1.3**.

3.18.2 *Locked Gear Ratio*

The control of the transmission such that the gear will not change during a test.

3.18.3 *Gear*

A discrete gear ratio either selectable by the driver or by an external device.

3.18.4 For vehicles tested according to **B-3.1.2.1** and Annex D, "gear (i)" and "gear (i+1)" are defined as two gears in sequence, where gear (i) either provides an acceleration within the 5 percent tolerance according to **B-3.1.2.1.4.1 (**a) or an acceleration greater than the reference acceleration, and gear (i+1) an acceleration lower than the reference acceleration according to **B-3.1.2.1.4.1** (b) or **B-3.1.2.1.4.1 (**c).

NOTE — The common understanding of a "low gear" or a "high gear" shall not apply to gear ratios. For example, the lowest gear for forward driving, the first gear, has the highest gear ratio of all forward driving gears. While manual transmission has discrete gears, many non-manual transmissions can have more gear ratios engaged by the control unit of the transmission.

3.19 Silencing System

A complete set of components necessary for limiting the sound produced by an engine, its intake and its exhaust.

NOTE — The exhaust manifold(s), the catalyst(s) and emission after-treatment device(s) are not considered part of the silencing system; these parts belong to the engine.

3.20 Design Family of Exhaust Silencing System or Exhaust Silencing System Components

A group of silencing systems or components thereof in which all of the following characteristics are the same:

a) The presence of net gas flow of the exhaust gases through the absorbing fibrous material when in contact with that material;

b) The type of the fibres;

c) Where applicable, binder material specifications;

d) Average fibre dimensions;

e) Minimum bulk material packing density in kg/m^3; and

f) Maximum contact surface between the gas flow and the absorbing material.

3.21 Exhaust Silencing System of Different Types

Silencing systems which significantly differ in respect of at least one of the following:

a) Trade names or trademarks of their components;

b) The characteristics of the materials constituting their components, except for the coating of those components;

c) The shape or size of their components;

d) The operating principles of at least one of their components;

e) The assembly of their components; and

f) The number of exhaust silencing systems or components.

3.22 Replacement Silencing System

Any part of the silencing system or its components intended for use on a vehicle, other than a part of the type fitted to this vehicle when submitted for type-approval pursuant to this standard.

3.23 R-point

A design point defined by the vehicle manufacturer for each seating position and established with respect to the three-dimensional reference system.

3.23.1 Symbols used in the standard are listed in Table1.

Table 1 Terms and Symbol
(*Clause* 3.23.1)

Sl. No.	**Symbol**	**Unit**	**Clause**	**Explanation**
(1)	(2)	(3)	(4)	(5)
i)	m_{ro}	Kg	**B-2.2.1**	Mass in running order; value to be reported and used for calculations to a precision of 10 kg.
ii)	m_{t}	Kg	**B-2.2.1**	Test mass of the vehicle; value to be reported and used for calculations to a precision of 10 kg.
iii)	m_{target}	Kg	**B-2.2.1**	Target mass of the vehicle.
iv)	$m_{\mathrm{x\ load}}$	Kg	**B-2.2.1**	Extra loading.
v)	$m_{\mathrm{fa\ load\ unladen}}$	Kg	**B-2.2.1**	front axle load in unladen condition
vi)	$m_{\mathrm{ra\ load\ unladen}}$	Kg	**B-2.2.1**	rear axle load in unladen condition
vii)	m_{unladen}	Kg	**B-2.2.1**	unladen vehicle mass
viii)	$m_{\mathrm{ac\ ra\ Max}}$	Kg	**B-2.2.1**	Technically permissible maximum laden mass allowed for the rear axle as declared by the manufacturer
ix)	m_{d}	Kg	**B-2.2.1**	mass of driver
x)	$m_{\mathrm{chassis\ M2M3}}$	Kg	**B-2.2.1**	mass of the incomplete vehicle (M2 or M3)
xi)	$m_{\mathrm{x\ load\ M2M3}}$	Kg	**B-2.2.1**	extra load to be added to the incomplete vehicle (M2 or M3) to reach the mass of the vehicle in running order as chosen by the manufacturer

Table 1 (*Continue*)

Sl. No.	**Symbol**	**Unit**	**Clause**	**Explanation**
(1)	(2)	(3)	(4)	(5)
xii)	$m_{\text{fa load laden}}$	Kg	**B-2.2.7.2**	front axle load in laden condition
xiii)	$m_{\text{ra load laden}}$	kg	**B-2.2.7.2**	rear axle load in laden condition
xiv)	$m_{\text{t (2 axles virtual)}}$	kg	**B-2.2.7.4**	test mass of a virtual vehicle with two axles (4 × 2 or 4 × 4)
xv)	v_{rf}	—	**B-2.2.7.4**	vehicle with more than two axles representing the vehicle family
xvi)	$m_{\text{unladen (2 axles virtual)}}$	kg	**B-2.2.7.4**	unladen vehicle mass of the virtual vehicle with two axles
xvii)	$m_{\text{xload (2 axles virtual)}}$	kg	**B-2.2.7.4**	extra loading for the virtual vehicle with two axles
xviii)	$m_{\text{ac ra max (chosen)}}$	kg	**B-2.2.7.4**	Technically permissible maximum laden mass allowed for the chosen rear axle as defined in **B-2.2.7.4**.
xix)	*AA'*	—	**B-3.1.1**	line perpendicular to vehicle travel which indicates beginning of zone in which to record sound pressure level during test
xx)	*BB'*	—	**B-3.1.1**	line perpendicular to vehicle travel which is 10.00 m behind line PP'
xxi)	*CC'*	—	**B-3.1.1**	line of vehicle travel through test surface defined in ISO 10844
xxii)	*PP'*	—	**B-3.1.1**	line perpendicular to vehicle travel which indicates location of microphones
xxiii)	v_{test}	km/h	**B-3.1.2.1**	vehicle test speed
xxiv)	PMR	—	**B-3.1.2.1.1**	power-to-mass ratio index to be used for calculations;

Table 1 (*Continue*)

Sl. No.	Symbol	Unit	Clause	Explanation
(1)	(2)	(3)	(4)	(5)
				value to be reported and used for calculations to the first decimal place
xxv)	P_n	kW	**B-3.1.2.1.1**	rated total engine net power
xxvi)	l	M	**B-3.1.2.1.2**	reference length; value to be reported and used for calculations to a precision of 0.01 m (1 cm)
xxvii)	l_veh	M	**B-3.1.2.1.2**	length of vehicle; value to be reported and used for calculations to a precision of 0.01 m (1 cm)
xxviii)	$v_{AA'}$	km/h	**B-3.1.2.1.2**	vehicle velocity when reference point passes line *AA'* (*see* **3.11** for definition of reference point); value to be reported and used for calculations to the first decimal place
xxix)	$v_\mathrm{BB'}$	km/h	**B-3.1.2.1.2**	vehicle velocity when reference point or rear of vehicle passes line BB' (*see* **3.11** for definition of reference point); value to be reported and used for calculations to the first decimal place
xxx)	$v_\mathrm{PP'}$	km/h	**B-3.1.2.1.2**	vehicle velocity when reference point passes line PP' (*see* **3.11** for definition of reference point); value to be reported and used for calculations to the first decimal place
xxxi)	$a_\mathrm{wot\ test}$	m/s^2	**B-3.1.2.1.2.1**	Acceleration at wide-open throttle from *AA'* to *BB'*; value to be reported and used for calculations to the second decimal place
xxxii)	$a_\mathrm{wot\ test(i)}$	m/s^2	**B-3.1.2.1.2.1**	acceleration at wide-open

Table 1 (*Continue*)

Sl. No.	**Symbol**	**Unit**	**Clause**	**Explanation**
(1)	(2)	(3)	(4)	(5)
				throttle achieved in a particular gear (i); value to be reported and used for calculations to the second decimal place
xxxiii)	l_{pa}	m	**B-3.1.2.1.2.1**	point of depressing the accelerator before line *AA'*; value to be reported in full metre
xxxiv)	$a_{\text{wot test, PP-BB}}$	m/s^2	**B-3.1.2.1.2.2**	Acceleration at wide-open throttle from PP' to BB'; value to be reported and used for calculations to the second decimal place
xxxv)	a_{urban}	m/s^2	**B-3.1.2.1.2.3**	target acceleration representing urban traffic acceleration; value to be reported and used for calculations to the second decimal place
xxxvi)	$a_{\text{wot ref}}$	m/s^2	**B-3.1.2.1.2.4**	reference acceleration for the wide-open-throttle test; value to be reported and used for calculations to the second decimal place
xxxvii)	k_{P}	—	**B-3.1.2.1.3**	partial power factor; value to be reported and used for calculations to the second decimal place
xxxviii)	$a_{\text{wot (i)}}$	m/s^2	**B-3.1.2.1.4.1**	acceleration at wide-open-throttle in gear ratio i; value to be reported and used for calculations to the second decimal place
xxxix)	$a_{\text{wot (i + 1)}}$	m/s^2	**B-3.1.2.1.4.1**	acceleration at wide-open-throttle in gear ratio (i + 1); value to be reported and used for calculations to the second decimal place

Table 1 (*Continue*)

Sl. No.	**Symbol**	**Unit**	**Clause**	**Explanation**
(1)	(2)	(3)	(4)	(5)
xl)	gear ratio (i)	—	**B-3.1.2.1.4.1**	gear ratio which provides an acceleration within the 5 percent tolerance of the reference acceleration $a_{\text{wot ref}}$ or greater than the reference acceleration $a_{\text{wot ref}}$
xli)	gear ratio (i+1)	—	**B-3.1.2.1.4.1**	second of two gear ratios, with an acceleration lower than gear ratio (i)
xlii)	gear ratio (i+2, i+3, …)	—	**B-3.1.2.1.4.1**	gear ratios selectable for the pass-by test of Annex B, if gear ratio i and gear ratio (i+1) exceed an acceleration of 2.0 m/s²
xliii)	k	—	**B-3.1.2.1.4.1**	Gear ratio weighting factor; value to be reported and used for calculations to the second decimal place
xliv)	$n_{\text{BB'}}$	1/min	**B-3.1.2.2**	engine rotational speed of the vehicle, when the reference point passes BB'; value to be reported and used for calculations to a precision of 10 min^{-1}
xlv)	S	1/min	**B-3.1.2.2**	rated engine rotational speed in revs per minute, synonymous with the engine rotational speed at maximum power
xlvi)	$n_{\text{target BB'}}$	1/min	**B-3.1.2.2.1.1** (a)	target engine rotational speed of the vehicle when the reference point has to pass line BB' (*see* **B-3.11.2** for definition of reference

Table 1 (*Continue*)

Sl. No.	**Symbol**	**Unit**	**Clause**	**Explanation**
(1)	(2)	(3)	(4)	(5)
				point)
xlvii)	$v_{\text{target BB'}}$	km/h	**B-3.1.2.2.1.1 (a)**	target vehicle velocity when it is necessary that the reference point has to pass line BB' (*see* **B-3.11.2** for definition of reference point)
xlviii)	$v_{\text{BB' gear (i)}}$	km/h	**B-3.1.2.2.1.1 (b)**	target vehicle velocity when certain conditions are met
xlix)	$v_{\text{BB' gear (i, i = 1,2)}}$	km/h	**B-3.1.2.2.1.1 (c)**	target vehicle velocity when certain conditions are met
l)	$gear_{\text{x}}$	—	**B-3.1.2.2.1.1 (d)**	first of two gear ratios used for testing of M2 having a maximum authorized mass of more than 3 500 kg, M3, N2, and N3 where certain criteria on test conditions are met
li)	$gear_{\text{y}}$	—	**B-3.1.2.2.1.1** (d)	second of two gear ratios used for testing of M2 having a maximum authorized mass of more than 3 500 kg M3, N2, and N3 where certain criteria on test conditions are met
lii)	$v_{\text{BB'x}}$	km/h	**B-3.1.2.2.1.1** (d)	target vehicle velocity when certain conditions are met
liii)	$v_{\text{BB'y}}$	km/h	**B-3.1.2.2.1.1** (d)	target vehicle velocity when certain conditions are met
liv)	$v_{\text{BB'1}}$	km/h	**B-3.1.2.2.1.2** (d)	target vehicle velocity when certain conditions are met
lv)	$v_{\text{BB'2}}$	km/h	**B-3.1.2.2.1.2** (d)	target vehicle velocity when certain conditions are met

Table 1 (*Continue*)

Sl. No.	**Symbol**	**Unit**	**Clause**	**Explanation**
(1)	(2)	(3)	(4)	(5)
lvi)	$n_{\mathrm{BB'(i)},\ \mathrm{i=1,2}}$	1/min	**B-3.1.2.2.1.2** (d)	engine rotational speed when the reference point passes BB' when certain conditions are met
lvii)	$L_{\mathrm{crs(i)}}$	dB(A)	**B-3.1.3.1**	vehicle sound pressure level at constant speed test for gear i; value to be reported and used for calculations to the first decimal place
lviii)	$L_{\mathrm{crs(i\ +1)}}$	dB(A)	**B-3.1.3.1**	vehicle sound pressure level at constant speed test for gear (i + 1); value to be reported and used for calculations to the first decimal place
lix)	$L_{\mathrm{crs\ rep}}$	dB(A)	**B-3.1.3.1**	reported vehicle sound pressure level at constant speed test; value to be reported and used for calculations to the first decimal place
lx)	$L_{\mathrm{wot(i)}}$	dB(A)	**B-3.1.3.1**	vehicle sound pressure level at wide- open-throttle test for gear (i); value to be reported and used for calculations to the first decimal place
lxi)	$L_{wot\mathrm{(i\ +1)}}$	dB(A)	**B-3.1.3.1**	vehicle sound pressure level at wide- open-throttle test for gear (i + 1); value to be reported and used for calculations to the first decimal place
lxii)	$L_{\mathrm{wot\ rep}}$	dB(A)	**B-3.1.3.1**	reported vehicle sound pressure level at wide-open-throttle; value to be reported and used for calculations to the first decimal place

Table 1 (*Continued*)

Sl. No.	**Symbol**	**Unit**	**Clause**	**Explanation**
(1)	(2)	(3)	(4)	(5)
lxiii)	L_{urban}	dB(A)	**B-3.1.3.1**	reported vehicle sound pressure level representing urban operation; value to be reported mathematically rounded to the nearest integer
lxiv)	$a_{\text{wot\_ASEP}}$	m/s^2	**D-2.3**	maximum required acceleration at wide-open-throttle
lxv)	κ	—	**D-2.3**	gears to be tested under "Additional Sound Emission Provisions" (ASEP)
lxvi)	$n_{\text{BB\_ASEP}}$	1/min	**D-2.3**	maximum test engine speed; value to be reported and used for calculations to a precision of 10 min-1
lxvii)	$v_{\text{AA'\_ASEP}}$	km/h	**D-2.3**	Target vehicle velocity for test point P1 of the assessment method according **D-2.4**
lxviii)	$v_{\text{BB'\_ASEP}}$	km/h	**D-2.3**	Target vehicle velocity for test point P4 of the assessment method according **D-2.4**
lxix)	Pj	—	**D-2.4**	test point(s) under ASEP
lxx)	j	—	**D-2.4**	index for the test points under ASEP
lxxi)	v_{BB_j}	km/h	**D-2.4**	vehicle test speed at BB' for a particular ASEP test point
lxxii)	$a_{\text{wot test},\kappa j}$	m/s^2	**D-2.5**	acceleration at wide-open throttle achieved in gear κ and at test point j
lxxiii)	$L_{\text{wot},\kappa j}$	dB(A)	**D-2.5**	sound pressure level measured for a gear κ and at a test point j; value to be reported and used for calculations to the first decimal place

Table 1 (*Continued*)

Sl No.	**Symbol**	**Unit**	**Clause**	**Explanation**
(1)	(2)	(3)	(4)	(5)
lxxiv)	$n_{\mathrm{BB},\kappa j}$	1/min	**D-2.5**	vehicle test engine speed at BB' for a gear κ and at test point j
lxxv)	$v_{\mathrm{AA},\kappa j}$	km/h	**D-2.5**	vehicle test speed at *AA'* for a gear κ and at test point j; value to be reported and used for calculations to the first decimal place
lxxvi)	$v_{\mathrm{BB},\kappa j}$	km/h	**D-2.5**	vehicle test speed at BB' for a gear κ and at test point j; value to be reported and used for calculations to the first decimal place
lxxvii)	$v_{\mathrm{PP},\kappa j}$	km/h	**D-2.5**	vehicle test speed at PP' for a gear κ and at test point j; value to be reported and used for calculations to the first decimal place
lxxviii)	L_{anchor}	dB(A)	**D-3.1**	reported vehicle sound pressure level for gear ratio (i) from Annex B; value to be reported and used for calculations to the first decimal place
lxxix)	$n_{\mathrm{anchor},\ \kappa}$	1/min	**D-3.1**	reported vehicle engine speed for gear ratio (i) from Annex B
lxxx)	$L_{\kappa j}$	dB(A)	**D-3.5**	sound pressure level measured for a gear κ and at a test point j; value to be reported and used for calculations to the first decimal place
lxxxi)	k_{P_ASEP}	—	**D-4.2.1**	partial power factor determined for the L urban principle of ASEP
lxxxii)	$L_{\mathrm{wot\_ASEP}}$	dB(A)	**D-4.2.1**	vehicle sound pressure level measured for the L_{urban} principle of ASEP; value to be reported and used for calculations to the first decimal place
lxxxiii)	$L_{\mathrm{urban\_measured\_ASEP}}$	dB(A)	**D-4.2.1**	interim result for calculation of $\Delta L_{\mathrm{urban\_ASEP}}$; value to be reported and used for calculations to the first decimal place

Table 1 (*Concluded*)

Sl No.	**Symbol**	**Unit**	**Clause**	**Explanation**
(1)	(2)	(3)	(4)	(5)
lxxxiv)	$L_{\text{urban\_normalized}}$	dB(A)	**D-4.2.1**	interim result for calculation of $\Delta L_{\text{urban\_ASEP}}$; value to be reported and used for calculations to the first decimal place
lxxxv)	$\Delta L_{\text{urban\_ASEP}}$	dB(A)	**D-4.2.1**	estimated deviation from urban sound pressure level; value to be reported to the first decimal place
lxxxvi)	α		**D-5.2**	Gear to be determined for the reference sound assessment according to the type of transmission
xxxvii)	L_{ref}	dB(A)	**D-5.3**	reference sound pressure level for reference sound assessment; value to be reported and used for calculations to the first decimal place
lxxxviii)	$n_{\text{BB'\_ref}}$	1/min	**D-5.3**	Reference vehicle test engine speed for reference sound assessment
lxxxix)	$v_{\text{BB'\_ref}}$	km/h	**D-5.3**	reference vehicle test speed for reference sound assessment

3.24 Mode

A distinct driver-selectable condition which does affect the sound emission of the vehicle.

3.25 Stable Acceleration

For the purpose of this standard, following three conditions are defined for stable acceleration:

a) ‘Stable acceleration’ applicable to all vehicles subject to this standard for low engine speed conditions, which eliminates power train reactions such as bumping and jerking;

b) ‘Stable acceleration’ applicable to vehicles of category M1, N1 and M2 < 3 500 kg technically permissible maximum laden mass avoids acceleration delays in acceleration due to engine control application, at the moment when the acceleration unit is depressed. This is typically ensured by using pre- acceleration; and

c) ‘Stable acceleration’ for the purpose of Annex G is based on the assumption of a constant acceleration over the complete measurement distance between AA' and BB' plus the vehicle length.

3.26 Kickdown

A driver initiated automated gear shift to a test condition outside the specific target conditions for the vehicle as defined in Annex B.

3.27 Prevention of Downshift

A measure by the vehicle manufacturer to ensure that the vehicle is tested within its specific target conditions as defined in Annex B and Annex D.

4 APPLICATION FOR APPROVAL

The application for approval of a vehicle type with regard to sound emission shall be submitted by its manufacturer or by his duly accredited representative.

5 MARKINGS

The components of the sound reduction system, exhaust or silencing system shall bear at least the following identifications:

a) The trade name or mark of the manufacturer of the exhaust or silencing system and of its components;

b) The trade description given by the manufacturer if any; and
c) Exhaust system with identification (if proprietary) or part no (if non- proprietary)

Such marking shall be indelible, clearly legible and also visible, in the position at which it is to be fitted to the vehicle.

6 APPROVAL OF VEHICLE

If the vehicle submitted for type approval meets the requirements of clause 7, approval of that vehicle type shall be granted. Information to be submitted at the time of application for type approval shall be as given in Annex A.

NOTE — In case the details are already submitted during first type approval then full details need to be submitted again in subsequent approvals.

6.1 Modification and Extension of the Approval of a Vehicle Type

6.1.1 Every modification of the vehicle type shall be notified to the testing/certifying agency which approved the vehicle type. The testing/certifying agency may then either:

a) Consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the vehicle still complies with the requirements; or
b) Any further test is required.

For considering whether testing is required or not, guidelines given in Table 6 shall be followed.

6.2 TRANSITIONAL PROVISIONS

6.2.1 At the request of the applicant, type approval for compliance to this standard shall be granted by testing/certifying agencies from (date of adoption in CMVR-TSC). Such type approval shall be deemed for compliance to IS 3028.

6.2.2 At the request of the applicant, type approval for compliance to IS 3028, shall be granted up to the notified date of implementation of this standard.

6.2.3 Type approval issued for compliance to IS 3028 shall be extended to approval of this standard subject to verification of Annex B and Annex D as applicable.

7 SPECIFICATIONS

7.1 General Specifications

7.1.1 The vehicle, its engine and its sound reduction system shall be so designed, constructed and assembled as to enable the vehicle, in normal use, despite the vibration to which it may be subjected, tocomply with the provisions of this standard.

7.1.2 The sound reduction system shall be so designed, constructed and assembled as to be able to reasonably resist the corrosive phenomena to which it is exposed having regard to the conditions of use of the vehicle, including regional climate differences.

7.2 Specifications Regarding Sound Levels

7.2.1 *Methods of Measurement*

7.2.1.1 The sound made by the vehicle type submitted for approval shall be measured either indoors or outdoors by the methods described in Annex B. The specific conditions for indoor testing are provided in Annex E. The results of the outdoor and indoor tests are deemed equivalent.

For each specific test condition for vehicles, the manufacturer can select to test the vehicle either indoors or outdoors. The Type Approval Authority shall always have the option to mandate an outdoor test for verification. The option of the type approval authority to mandate an outdoor test shall apply to any test specified in this Standard, including conformity of production testing.

In addition, the sound shall be measured on the stationary vehicle; in the case of a vehicle where an internal combustion engine cannot operate when the vehicle is stationary, the emitted sound shall only be measured in motion. In the case of a hybrid electrical vehicle of category M1 where an internal combustion engine cannot operate when the vehicle is stationary, the emitted sound shall be measured according to **B-4**.

Vehicles having a technically maximum permissible laden mass exceeding 2 800 kg shall be subjected to an additional measurement of the compressed air noise with the vehicle stationary in accordance with the specifications of Annex F, if the corresponding brake equipment is part of the vehicle.

7.2.1.2 The values measured in accordance with the provisions of **7.2.1.1** shall be entered in the test report and a certificate corresponding to the model shown in Annex A.

7.3 Sound Level Limits

7.3.1 The sound level measured in accordance with the provisions of **B-3.1**, mathematically rounded to the nearest integer value, shall not exceed the limits prescribed in Table 2.

Table 2 Maximum Limit of Sound Levels

(*Clause* 7.3.1)

Sl No.	Vehicle Category	Vehicles Used for the Carriage of Passengers	Limit Values [dB(A)]
(1)	(2)	(3)	(4)
i)	M1	PMR ≤ 120	(As specified by statutory Authority)
		120 < PMR ≤ 160	
		PMR > 160	
		PMR > 200, no. of seats ≤ 4, R-point height < 450 mm from the ground	
ii)	M2	M ≤ 2.5 t	(As specified by statutory Authority)
		2.5 t < M ≤ 3.5 t	
		M > 3.5 t; P_n ≤ 135 kW	
		M > 3.5 t; P_n > 135 kW	
iii)	M3	P_n ≤ 150 kW	(As specified by statutory Authority)
		150 kW < P_n ≤ 250 kW	
		P_n > 250 kW	
iv)	N1	M ≤ 2.5 t	(As specified by statutory Authority)
		M > 2.5 t	
v)	N2	P_n ≤ 135kW	(As specified by statutory Authority)
		P_n > 135 kW	
vi)	N3	P_n ≤ 150 kW	(As specified by statutory Authority)
		150 kW < P_n ≤ 250 kW	
		P_n > 250 kW	

7.3.1.1 For vehicle types of category M1 derived from N1 vehicle types having a technically permissible maximum laden mass above 2.5 tons and a R-point height greater than 850 mm from the ground, the limits of vehicles types of category N1 having a technically permissible maximum laden mass above 2.5 tons shall apply.

7.3.1.2 For vehicle types of category M3 having a gasoline only engine, the applicable limit value is increased by 2 dB (A).

7.3.1.3 For vehicle types of category N1 having a technically permissible maximum laden mass ≤ 2.5 tons, the engine capacity not exceeding 660 cc and the power-to-mass ratio (PMR) calculated by using the technically permissible maximum laden mass not exceeding 35 and a horizontal distance "d" between the front axle and the driver's seat R-point of less than 1 100 mm, the limits of the vehicle types of category N1 having a technically permissible maximum laden mass above 2.5 tons shall apply.

7.3.2 *Additional Sound Emission Provisions* (*Optional*)

The Additional Sound Emission Provisions (ASEP) apply only to vehicles of categories M1 and N1 equipped with an internal combustion engine. Vehicles are deemed to fulfil the requirements of Annex D, if the vehicle manufacturer provides technical documents to the testing/certifying agency showing, that the difference between maximum and minimum engine speed of the vehicles at BB' for any test condition inside the ASEP control range defined in **D-3.3** (including Annex B conditions) does not exceed 0.15 × S. This article is intended especially for non-lockable transmissions with variable gear ratios (CVT).

Vehicles are exempted from ASEP, if one of the following conditions is fulfilled:

a) For vehicles of category N1, if the enginecapacity does not exceed 660 cc and the power-to-mass ratio PMR calculated by using the technically permissible maximum laden mass does not exceed 35

b) For vehicles of category N1, if the payload is at least 850 *kg* and the power-to-mass ratio calculated by using the technically permissible maximum laden mass does not exceed 40; and

c) For vehicles of category N1 or M1 derived from N1 if the technically permissible maximum laden mass is greater than 2.5 tons and the R- point height is greater than 850 mm from the ground and the power-to-mass ratio calculated by using the technically permissible maximum laden mass does not exceed 40.

The sound emission of the vehicle under typical on-road driving conditions, which are different from those under which the type-approval test set out in Annex B and Annex D was carried out, shall not deviate from the test result in a significant manner. Any electric sound enhancement system for the purpose of the exterior sound emission shall be operational during the type-approval test.

7.3.2.1 The vehicle manufacturer shall not intentionally alter, adjust, or introduce any mechanical, electrical, thermal, or other device or procedure solely for the purpose of fulfilling the sound emission requirements as specified under this standard which is not operational during typical on- road operation.

7.3.2.2 The vehicle shall meet the requirements of Annex D.

7.3.2.3 In applying for type approval, the manufacturer shall provide a statement, in conformity with the **D-6.3**, that the vehicle type to be approved complies with the requirements of **7.3.2.**

7.3.2.4 Specifications regarding exhaust systems containing fibrous materials, requirements of Annex C shall be applied.

ANNEX A

(*Clauses* 6, 7.2.1.2 *and* B-2.2.2)

TECHNICAL INFORMATION DOCUMENT TO BE SUBMITTED BY MANUFACTURER

A-0 GENERAL

A-0.1 Make (trade name of manufacturer): ....

A-0.2 Type: ....

A-0.3 Means of identification of type, if marked on the vehicle: ……….................................

NOTE — If the means of identification of type contains characters not relevant to describe the vehicle types covered by the type-approval certificate such characters shall be represented in the documentation by the symbol: '?' (for example, ABC??123??)

A-0.3.1 Location of that marking: ....

A-0.4 Category of vehicle: ....……..

A-0.5 Company name and address of manufacturer: ....

A-0.6 Name and address of the manufacturer's representative (if any): ....

A-0.7 Name(s) and address(es) of assembly plant(s): ....

A-1 GENERAL CONSTRUCTION CHARACTERISTICS OF THE VEHICLE

A-1.1 Photographs and/or drawings of a representative vehicle: ....

A-1.2 Number of axles and wheels: ....

NOTE — Only for the purpose of defining "off-road vehicles".

A-1.2.1 Powered axles (number, position, interconnection): ....

A-1.3 Position and arrangement of the engine: ....

A-2 MASSES AND DIMENSIONS (in kg and mm) (Refer to drawing where applicable):

NOTES

1. Standard ISO 612: 1978 — Road vehicles — Dimensions of motor vehicles and towed vehicles — Terms and definitions.
2. Where there is one version with a normal cab and another with a sleeper cab, both sets of masses and dimensions are to be stated.
3. Optional equipment that affects the dimensions of the vehicle shall be specified.

A-2.1 Range of vehicle dimensions (overall): ....

A-2.1.1 For chassis without body work: ....

A-2.1.1.1 Length: ....……

A-2.1.1.2 Width: ....

A-2.1.2 For chassis with body work: …..

A-2.1.2.1 Length: ....

A-2.1.2.2 Width: ....….

A-2.2 Mass in running order

a) Minimum and maximum for each variant: ....

b) Mass of each version (a matrix shall be provided): ....

NOTE — The mass of the driver is assessed at 75 kg. The liquid containing systems (except those for used water that shall remain empty) are filled to 90 per cent of the capacity specified by the manufacturer. The information referred to in points 2.2 b) do not need to be provided for vehicle categories N2, N3, M2 and M3.

A-2.3 Technically permissible maximum laden mass stated by the manufacturer:

NOTE — For vehicles coupled with a trailer or a semi-trailer, which exert a significant vertical load on the coupling device or the fifth wheel, this load, divided by standard acceleration of gravity, is included in the maximum technically permissible mass. Please fill in here the upper and lower values for each variant. Please fill in here the upper and lower values for each variant.

A-3 POWER PLANT

NOTE — In the case of a vehicle that can run either on petrol, diesel, etc, or also in combination with another fuel, items shall be repeated. In the case of non-conventional engines and systems, particulars equivalent to those referred here shall be supplied by the manufacturer.

A-3.1 Manufacturer of the engine: ....

A-3.1.1 Manufacturer's engine code (as marked on the engine, or other means of identification): ....

A-3.2 Internal combustion engine

A-3.2.1 Specific engine information

A-3.2.1.1 Working principle: positive ignition/compression ignition, cycle four stroke/two stroke/rotary

NOTE — Delete what does not apply.

A-3.2.1.2 Number and arrangement of cylinders: ....

A-3.2.1.2.1 Firing order: ....

A-3.2.1.3 Engine capacity ………………………………………………………………… cm^3

NOTE — This value shall be calculated ($\pi = 3.1416$) and rounded off to the nearest cm^3.

A-3.2.1.4 Rated maximum net power:……. kW at ….. min^{-1} (manufacturer's declared value)

A-3.2.2 Fuel feed

A-3.2.2.1 By fuel injection (compression ignition only): Yes/No

A-3.2.2.1.1 Working principle: Direct injection/pre-chamber/swirl chamber

A-3.2.2.1.2 Governor

A-3.2.2.1.2.1 Type: ....

A-3.2.2.1.2.2 Speed at which Cut-off starts under load: ……………………………… min–1

A-3.2.2.2 By fuel injection (positive ignition only): Yes/No

A-3.2.2.2.1 Working principle: Intake manifold (single/multi-point2)/direct injection/other (specify)

A-3.2.3 Intake system

A-3.2.3.1 Air filter, drawings, or

A-3.2.3.1.1 Make(s): ....

A-3.2.3.1.2 Type(s): ....

A-3.2.3.2 Intake silencer, drawings,

A-3.2.3.2.1 Make(s): ....

A-3.2.3.2.2 Type(s): ....

A-3.2.4 Exhaust system

A-3.2.4.1 Description and/or drawing of the exhaust system: ....

A-3.2.4.2 Exhaust silencer(s): ....

a) Type, marking of exhaust silencer(s): ....
b) Where relevant for exterior noise, reducing measures in the engine compartment and on the engine: ....

A-3.2.4.3 Location of the exhaust outlet:...
.

A-3.2.4.4 Exhaust silencer containing fibrous materials: ....

A-3.2.5 Catalytic convertor: Yes/No

A-3.2.5.1 Number of catalytic convertors and elements (provide the information below for each separate unit): ....

A-3.2.6 Pressure charger(s)

A-3.2.6.1 Make(s): ……………………………………………………………………………..

A-3.2.6.2 Type(s): ……………………………………………………………………………...

A-3.3 Electric motor

A-3.3.1 Type (winding, excitation): ....

A-3.3.1.1 Maximum hourly output: ……………………………………………………. kWA.

A-3.3.1.2 Operating voltage: ……………………………………………………………… V

A-3.4 Engine or motor combination: ....

A-3.4.1 Hybrid electric vehicle: Yes/No

A-3.4.2 Category of hybrid electric vehicle: off-vehicle charging/not off-vehicle charging

A-3.4.3 Operating mode switch: With/Without

A-3.4.3.1 Selectable modes

a) Pure electric: Yes/No
b) Pure fuel consuming: Yes/No
c) Hybrid modes: Yes/No (if yes, short description):

A-3.4.4 Electric motor (describe each type of electric motor separately)

a) Make: ....

b) Type: ....
c) Rated maximum net power: ……………………………………… kW

A-4 TRANSMISSION

NOTE — The specified particulars are to be given for any proposed variants.

A-4.1 Type (mechanical, hydraulic, electric, etc): ....

A-4.2 Gear ratios

Gear	*Internal gearbox ratios (ratios of engine to gearbox output shaft revolutions)*	*Final drive ratio(s) (ratio of gearbox output shaft to driven wheel revolutions)*	*Total gear ratios*
Maximum for Continuous Variable Transmission (CVT): transmission with variable gear ratios			
1			
2			
3			
…			
Minimum for CVT			
Reverse			

A-4.3 Maximum vehicle design speed (in km/h): ....

NOTE — With respect to trailers, maximum speed permitted by the manufacturer.

A-5 SUSPENSION

A-5.1 Tyres and wheels

A-5.1.1 Tyre/wheel combination(s)

a) For tyres indicate size designation, load-capacity index and speed category symbol;
b) For wheels indicate rim size(s) and off-set(s).

A-5.1.2 Upper and lower limits of roll in gradii

a) Axle 1: ....
b) Axle 2: ....
c) Axle 3: ....
d) Axle 4: ....

A-6 BODYWORK

A-6.1 Type of bodywork: ....

A-6.2 Materials used and methods of construction: ....

A-7 MISCELLANEOUS

A-7.1 Details of any non-engine devices designed to reduce noise (if not covered by other items): ....

Signed: ....

Position in company: ....

Date: ....

ANNEX B

(*Clause* 3.8.1)

METHODS AND INSTRUMENTS FOR MEASURING THE SOUND MADE BY MOTOR VEHICLES

B-1 MEASURING INSTRUMENTS

B-1.1 Acoustic Measurements

B-1.1.1 *General*

The apparatus used for measuring the sound level shall be a precision sound-level meter or equivalent measurement system meeting the requirements of Class 1 instruments (inclusive of the recommended windscreen, if used). These requirements are described in "IEC 61672-1: 2002 Precision sound level meters", second edition, of the International Electrotechnical Commission (IEC).

For indoor testing, when no general statement or conclusion can be made about conformance of the sound level meter by each channel of the array conformance (for example, when pass-by sound level simulation algorithms do not compute the overall level but spectrum or temporal to recompose it), a simulated pass-by run shall be performed at a constant speed of 50 km/h while a constant tone signal is supplied to all channels of the arrays. The simulated A-weighted sound level is processed and the deviation from a reference tone signal shall be checked in accordance to IEC 61672-3.

Measurements shall be carried out using the "fast" response of the acoustic measurement instrument and the "A" weighting curve also described in "IEC 61672-1: 2002". When using a system that includes a periodic monitoring of the A-weighted sound pressure level, a reading should be made at a time interval not greater than 30 ms.

The instruments shall be maintained and calibrated in accordance to the instructions of the instrument manufacturer.

B-1.1.2 *Calibration of the Entire Acoustic Measurement System for a Measurement Session*

At the beginning and at the end of every measurement session the entire measurement system shall be checked by means of a sound calibrator that fulfils the requirements for sound calibrators of at least precision Class 1 according to IEC 60942: 2017. Without any further adjustment the difference between the readings of two consecutive checks shall be less than or equal to 0.5 dB (A).

If this value is exceeded, the results of the measurements obtained after the previous satisfactory check shall be discarded.

For indoor testing, the entire measurement system shall be checked at the beginning and at the end of a series of sessions.

A qualified calibration method (that is, electrical calibration) is recommended to be provided by the hardware supplier and, in that case, shall be implemented in the measurement software used. Simulation algorithms using sound source localization detection should deactivate that feature for these tests.

B-1.1.3 *Compliance with Requirements*

Compliance of the acoustic measurement instrumentation shall be verified by the existence of a valid certificate of compliance. These certificates shall be deemed to be valid if certification of compliance with the standards was conducted within the previous 12 month period for the sound calibration device and within the previous 24 month period for the instrumentation system. All compliance testing shall be conducted by a laboratory, which is authorized to perform calibrations traceable to the appropriate standards.

B-1.2 Instrumentation for Speed Measurements

The engine speed shall be measured with instrumentation having an accuracy of ± 2 percent or better at the engine speeds required for the measurements being performed.

The road speed of the vehicle shall be measured with instrumentation having an accuracy of atleast ± 0.5 km/h, when using continuous measurement devices. If testing uses independent measurements of speed, this instrumentation shall meet specification limits of at least ± 0.2 km/h.

B-1.3 Meteorological Instrumentation

The meteorological instrumentation used to monitor the environmental conditions during the test shall include the following devices, which meet at least the following given accuracy:

a) Temperature measuring device: ± 1°C;
b) Wind speed-measuring device: ± 1.0 m/s;
c) Barometric pressure measuring device: ± 5 hPa; and
d) A relative humidity measuring device: ± 5 percent.

B-2 CONDITIONS OF MEASUREMENT

B-2.1 Test Site and Ambient Conditions

The specifications for the test site provide the necessary acoustic environment to carry out the vehicle tests documented in this Standard. Outdoor and indoor test environments that meet the specifications of this Standard provide equivalent acoustic environments and produce results that are equally valid.

B-2.1.1 *Test Site Outdoor*

The surface of the test track and the dimensions of the test site shall be in accordance with ISO 10844 : 2014.

B-2.1.2 *Test Site Indoor*

Test Site Indoor requirements shall be as specified below:

a) The test room dimensions are described in **7.2** of ISO 362-3 : 2016. All room dimensions may be adjusted to meet the specific application for the products being tested according to **E-4**.

b) The test facility shall meet the requirements of ISO 26101 : 2012 with the qualification criteria and measurement requirements appropriate to this test method as described in **7.3** of ISO 362-3 : 2016.

c) Condition of the floor is described in **7.4** of ISO 362-3: 2016.

d) Cooling, ventilation and exhaust gas management are described in **7.5** of ISO 362-3: 2016.

e) Dynamometer requirements are described in **8** of ISO 362-3 : 2016.

f) Vehicle fixing system is described in **9.3** of ISO 362-3 : 2016.

B-2.1.3 *Ambient Conditions*

The surface of the site shall be free of powdery snow, tall grass, loose soil or cinders. There shall be no obstacle which could affect the sound field within the vicinity of the microphone and the sound source. The observer carrying out the measurements shall so position themselves as not to affect the readings of the measuring instrument.

Measurements shall not be made under adverse weather conditions. It shall be ensured that the results are not affected by gusts of wind.

The meteorological instrumentation should be positioned adjacent to the test area at a height of (1.2 ± 0.02) m. The measurements shall be made when the ambient air temperature is within the range from 5 °C to 45 °C.

Tests carried out on request of the manufacturer at temperatures below 5°C shall be accepted as well.

The tests shall not be carried out if the wind speed, including gusts, at microphone height exceeds 5 m/s, during the sound measurement interval.

A value representative of temperature, wind speed and direction, relative humidity, and barometric pressure shall be recorded during the sound measurement interval.

Any sound peak which appears to be unrelated to the characteristics of the general sound level of the vehicle shall be ignored in taking the readings.

The background noise shall be measured for duration of 10 s immediately before and after a series of vehicle tests. The measurements shall be made with the same microphones and microphone locations used during the test. The A-weighted maximum sound pressure level shall be reported.

The background noise (including any wind noise) shall be at least 10 dB (A) below the A-weighted sound pressure level produced by the vehicle under test. If the difference between the ambient noise and the measured sound is between 10 dB and 15 dB (A), in order to calculate the test results the appropriate correction shall be subtracted from the readings on the sound-level meter, as in the Table 3.

Table 3 Correction Applied to Individual Measured Test Value

(*Clause* B-2.1.3)

Difference between ambient noise and sound to be measured dB(A)	10	11	12	13	14	15
Correction dB(A)	0.5	0.4	0.3	0.2	0.1	0.0

For indoor testing, background noise shall take into account noise emissions produced by the dynamometer rollers, ventilation systems and facility exhaust gas systems.

B-2.2 Vehicle

B-2.2.1 The vehicle shall be representative of vehicles to be put on the market as specified by the manufacturer in agreement with the Technical Service to fulfil the requirements of this standard.

Measurements shall be made without any trailer, except in the case of non-separable vehicles. At the request of the manufacturer, measurements may be made on vehicles with lift axle(s) in a raised position. Measurements shall be made on vehicles at the test mass m_t specified according to the Table 4.

When testing indoors, the test mass, m_t shall be utilized by the control system of the dyno roller. Actual mass of the vehicle has no effect on results and it is permitted to load the vehicle as necessary to prevent slip between the tyres and the dyno rolls. To detect excessive slip, it is recommended to control the ratio of engine rotational speed and vehicle speed between the acceleration phase and the constant-speed status. To avoid slip, it is possible to increase the axle load.

Target mass (m_{target}) is used to denote the mass that N2 and N3 vehicles should be tested at. The actual test mass of the vehicle can be less due to limitations on vehicle and axle loading.

Table 4 Vehicles Test Mass

(*Clause* B-2.2.1, B-2.2.7.1, B-3.1.2.1 and B-3.1.2.2)

Vehicle category	Vehicle Test Mass
M1	The test mass m_t of the vehicle shall be between 0.9 $m_{ro} \leq m_t \leq 1.2\ m_{ro}$
N1	The test mass m_t of the vehicle shall be between 0.9 $m_{ro} \leq m_t \leq 1.2\ m_{ro}$
N2, N3	m_{target} = 50 [kg/kW] x P_n [kW] Extra loading, $m_{x\ load}$, to reach the target mass, m_{target}, of the vehicle shall be placed above the rear axle(s). If the test mass mt is equal to the target mass m target, the test mass mt shall be 0.95 m target $\leq m_t \leq$ 1.05 m_{target} The sum of the extra loading and the rear axle load in an unladen condition, $m_{ra\ load\ unladen}$, is limited to 75 percent of the technically permissible maximum laden mass allowed for the rear axle, $m_{ac\ ra\ Max}$. If the test mass mt is lower than the target mass m_{target}, the test mass m_t shall be achieved with a tolerance of ± 5 percent. If the centre of gravity of the extra loading cannot be aligned with the centre of the rear axle, the test mass, m_t, of the vehicle shall not exceed the sum of the front axle

Table 4 (*Concluded*)

Vehicle category	**Vehicle Test Mass**
	in an unladen condition, $m_{\text{fa load unladen}}$, and the rear axle load in an unladen condition, $m_{\text{ra load unladen}}$ plus the extra loading, $m_{\text{x load}}$, and the mass of the driver m_{d}. The test mass for vehicles with more than two axles shall be the same as for a two-axle vehicle. If the vehicle mass of a vehicle with more than two axles in an unladen condition, m_{unladen}, is greater than the test mass for the two-axle vehicle, then this vehicle shall be tested without extra loading. If the vehicle mass of a vehicle with two axles, m_{unladen}, is greater than the target mass, then this vehicle shall be tested without extra loading.
M2 (M ≤ 3 500 kg)	The test mass m_{t} of the vehicle shall be between $0.9m_{\text{ro}} \leq m_{\text{t}} \leq 1.2\ m_{\text{ro}}$
Complete	If the tests are carried out with a complete vehicle
M2 (M > 3 500 kg), M3	having a bodywork, m_{target} = 50 [kg/kW] x P_{n} [kW] is calculated either in compliance with conditions above (*see* N2, N3 category) or the test mass m_{t} of the vehicle shall be $0.9\ m_{\text{ro}} \leq m_{\text{t}} \leq 1.1\ m_{\text{ro}}$.
Incomplete	If the tests are carried with an incomplete vehicle not
M2 (M > 3 500 kg), M3	having a bodywork, m_{target} = 50 [kg/kW] x P_{n} [kW] is calculated either in compliance with conditions above (*see* N2, N3 category); or the test mass m_{t} of the vehicle shall be $0.9\ m_{\text{ro}} \leq m_{\text{t}} \leq 1.1\ m_{\text{ro}}$. where $m_{\text{ro}} = m_{\text{chassis M2 M3}} + m_{\text{x load M2 M3}}$.

B-2.2.2 At the applicant's request the vehicle of a category M2, M3, N2 or N3 is deemed representative of its completed type if the tests are carried out to an incomplete vehicle not having a bodywork. In the test of an incomplete vehicle all relevant soundproofing materials, panels and noise reduction components and systems shall be fitted on the vehicle as designed by the manufacturer except a part of bodywork which is built in a later stage.

No new test shall be required due to fitting of a supplement fuel tank or re-location of the original fuel tank on condition that other parts or structures of the vehicle apparently affecting sound emissions have not been altered.

The tyres to be used for the test shall be representative for the vehicle and shall be selected by the vehicle manufacturer and recorded in Addendum to the communication form (*see* Annex A). They shall correspond to one of the tyre sizes designated for the vehicle as original equipment. The tyre is or will be commercially available on the market at the same time as the vehicle. The tyres shall be inflated to the pressure recommended by the vehicle manufacturer for the test mass of the vehicle. The tyres shall have at least 1.6 mm tread depth.

NOTE — Given that the tyre contribution for overall sound emission is significant, regard shall be given for existing regulatory provisions concerning tyre/road sound emissions. Traction tyres, snow tyres and special-use tyres shall be excluded during type-approval measurements.

When performing indoor testing, tyre/road sound is evaluated independently on the test track with the tyres to be used, according to this paragraph. Propulsion sound is independently evaluated on the dynamometer using tyres and other sound control measures to produce tyre/road sound which does not influence the measurement result.

B-2.2.3 Before the measurements are started, the engine shall be brought to its normal operating conditions.

B-2.2.4 If the vehicle is fitted with more than two-wheel drive, it shall be tested in the drive which is intended for normal road use.

B-2.2.5 If the vehicle is fitted with fan(s) having an automatic actuating mechanism, this system shall not be interfered with during the measurements.

B-2.2.6 If the vehicle is equipped with an exhaustsystem containing fibrous materials, it might be necessary to carry out a conditioning test prior to testing. The provisions of **C-1** in conjunction with the flowchart given in Fig. 12 in Annex C shall be followed.

B-2.2.7 *Calculation Procedure to Determine Extra Loading of N2 and N3 Vehicles Only*

B-2.2.7.1 *Calculation of extra loading*

The target mass (m_{target}), (per kW rated power) for two-axle vehicles of category N2 and N3 is specified in the Table 4.

Formula (1):

$$m_{\text{target}} = 50\ [\text{kg/kW}] \times P_{\text{n}}[\text{kW}]$$

To reach the required target mass (m_{target}), for a vehicle being tested, the unladen vehicle, including the mass of the driver (m_{d}), shall be loaded with an extra mass ($m_{\text{x load}}$), which shall be placed above the rear axle as given in Formula (8):

Formula (2):

$$m_{\text{target}} = m_{\text{unladen}} + m_{\text{d}} + m_{\text{x load}}$$

The target mass (m_{target}), shall be achieved with a tolerance of ± 5 percent.

The vehicle mass of the test vehicle in the unladen condition (m_{unladen}), is calculated by measuring on a scale the unladen front axle load ($m_{\text{fa load unladen}}$), and the unladen rear axle load ($m_{\text{ra load unladen}}$), as given in Formula (3):

Formula (3):

$$m_{\text{unladen}} = m_{\text{fa load unladen}} + m_{\text{ra load unladen}}$$

By using Formula (2) and (3), the extra loading ($m_{\text{x load}}$), is calculated as given in Formulae (4) and (5):

Formula (4):

$$m_{\text{x load}} = m_{\text{target}} - (m_{\text{d}} + m_{\text{unladen}})$$

Formula (5):

$$m_{\text{x load}} = m_{\text{target}} - (m_{\text{d}} + m_{\text{fa load unladen}} + m_{\text{ra load unladen}})$$

The sum of the extra loading ($m_{\text{x load}}$), and the unladen rear axle load ($m_{\text{ra load unladen}}$), is limited to 75 percent of the technically permissible maximum laden mass for the rear axle ($m_{\text{ac ra Max}}$), as given in Formula (6):

Formula (6):

$$0.75\ m_{\text{ac ra Max}} \geq m_{\text{xload}} + m_{\text{ra load unladen}}$$

The $m_{\text{x load}}$ is limited according to Formula (7):

Formula (7):

$$m_{\text{x load}} \leq 0.75\ m_{\text{ac ra Max}} - m_{\text{ra load unladen}}$$

If the calculated extra loading ($m_{\text{x load}}$), in Formula (5) fulfils Formula (7), then the extra loading is equal to Formula (5). The test mass (m_{t}), of the vehicle is as calculated from Formula (8):

Formula (8):

$$m_{\text{t}} = m_{\text{x load}} + m_{\text{d}} + m_{\text{fa load unladen}} + m_{\text{ra load unladen}}$$

In this case, the test mass of the vehicle is equal to the target mass.

Formula (9):

$$m_{\text{t}} = m_{\text{target}}$$

If the calculated extra loading ($m_{\text{x load}}$), in Formula (5) does not fulfil Formula (7), but rather fulfils Formula (10)

Formula (10):

$$m_{\text{x load}} > 0.75\ m_{\text{ac ra Max}} - m_{\text{ra load unladen}}$$

then, the extra loading ($m_{\text{x load}}$) , shall be as given by Formula (11):

Formula (11):

$$m_{\text{x load}} = 0.75\ m_{\text{ac ra Max}} - m_{\text{ra load unladen}}$$

and the test mass (m_t), of the vehicle shall be as given by Formula (12):

Formula (12):

$$m_{\text{t}} = 0.75\ m_{\text{ac ra Max}} + m_{\text{d}} + m_{\text{fa load unladen}}$$

In this case, the test mass of the vehicle is lower than the target mass.

Formula (13):

$$m_{\text{t}} < m_{\text{target}}$$

The test mass (m_{t}), shall be achieved with a tolerance of ± 5 percent.

B-2.2.7.2 *Loading considerations if load cannot be aligned with the center of rear axle*

If the centre of gravity of the extra loading ($m_{\text{x load}}$), cannot be aligned with the centre of the rear axle, the test mass of the vehicle (m_{t}), shall not exceed the sum of the unladen front axle load ($m_{\text{fa load unladen}}$), and the unladen rear axle load ($m_{\text{ra load unladen}}$), plus the extra loading ($m_{\text{x load}}$), and the mass of the driver (m_{d}).

This means that if the actual front and rear axle loads are measured on a scale when the extra loading (mx load), is placed onto the vehicle and it is aligned with the centre of the rear axle, the test mass of the vehicle minus the mass of the driver is as given by Formula (14):

Formula (14):

$$m_{\text{t}} - m_{\text{d}} = m_{\text{fa load laden}} + m_{\text{ra load laden}}$$

where

Formula (15):

$$m_{\text{fa load laden}} = m_{\text{fa load unladen}}$$

If the centre of gravity of the extra loading cannot be aligned with the centre of the rear axle, Formula (14) is still fulfilled, but

Formula (16):

$$m_{\text{fa load laden}} > m_{\text{fa load unladen}}$$

because the extra loading has partly distributed its mass to the front axle. In that case, it is not allowed to add more mass onto the rear axle to compensate for the mass moved to the front axle.

B-2.2.7.3 *Test mass for vehicles with more than two axles*

If a vehicle with more than two axles is tested, then the test mass of this vehicle shall be the same as the test mass for the two-axle vehicle. If the unladen vehicle mass of a vehicle with more than two axles is greater than the test mass for the two-axle vehicle, then this vehicle shall be tested without extra loading.

B-2.2.7.4 *Calculation of the test mass of a virtual vehicle with two axles*

When a vehicle family is not represented by a two-axle vehicle because it is physically not available, the vehicle family can be represented by a vehicle with more than two axles (v_{rf}). In that case the test mass of a virtual two-axle vehicle [$m_{\text{t (2 axles virtual)}}$] can be calculated in the following way:

For the calculation of the unladen vehicle mass of the virtual two-axle vehicle [$m_{\text{unladen (2 axles virtual)}}$], take from the vehicle with more than two axles (v_{rf}) the measured unladen front axle load [m_{fa} (v_{rf}) $_{\text{load unladen}}$] and the measured unladen rear axle load of that driven rear axle [m_{fa} (v_{rf}) $_{\text{load unladen}}$] which has the highest unladen load.

If the vehicle (v_{rf}) has more than one front axle, take the one with the highest unladen front axle load.

$$m_{\text{unladen}} (\text{2 axles virtual}) = m_{\text{fa}} (v_{\text{rf}})_{\text{ load unladen}} + m_{\text{ra}} (v_{\text{rf}})_{\text{ load unladen}}$$

$$m_{\text{x load}} (\text{2 axles virtual}) = m_{\text{target}} - [m_{\text{d}} + m_{\text{unladen}} (2 \text{ axles virtual})]$$

Due to the requirement that the sum of the extra loading [$m_{\text{x load (2 axles virtual)}}$] and the unladen rear axle load [m_{ra} (v_{rf})$_{\text{load unladen}}$], is limited to 75 percent of the technically permissible maximum laden mass allowed for the rear axle [$m_{\text{ac ra Max (2 axles virtual)}}$], this value [$m_{\text{ac ra Max (2 axles virtual)}}$)], has to be chosen in such a way that it represents the rear axle of the forecasted highest production - volume in the manufacturer's variation with a technically permissible maximum laden mass allowed for the rear axle [$m_{\text{ac ra Max (chosen)}}$] for the vehicle family as declared by the manufacturer.

$$m_{\text{ac ra Max (4 x 2 virtual)}} = m_{\text{ac ra Max (chosen)}}$$

If, $m_{\text{x load (2 axles virtual)}} \leq 0.75\ m_{\text{ac ra Max (chosen)}} - m_{\text{ra}}$ (v_{rf}) $_{\text{load unladen}}$; then

$m_{\text{t (2 axles virtual)}} = m_{\text{x load (2 axles virtual)}} + m_{\text{d}} + m_{\text{fa}} (v_{\text{rf}})_{\text{ load unladen}} + m_{\text{ra}} (v_{\text{rf}})_{\text{ load unladen}}$; and

$m_{\text{t (2 axles virtual)}} = m_{\text{target}}$
If, $m_{\text{x load (2 axles virtual)}} > 0.75\ m_{\text{ac ra Max (chosen)}} - m_{\text{ra}} (v_{\text{rf}})_{\text{ load unladen}}$; then

$m_{\text{t (2 axles virtual)}} = 0.75\ m_{\text{ac ra Max (chosen)}} + m_{\text{d}} + m_{\text{fa}} (v_{\text{rf}})_{\text{ load unladen}}$; and

$$m_{\text{t (2 axles virtual)}} < m_{\text{target}}$$

The test mass of the vehicle with more than two axles representing the vehicle family is defined as followed:

m_{t} (v_{rf}) = $m_{\text{t (2 axles virtual)}}$; and the extra loading is calculated as

$$m_{\text{x load}} (v_{\text{rf}}) = m_{\text{t (2 axles virtual)}} - m_{\text{d}} - m_{\text{unladen}} (v_{\text{rf}})$$

B-3 METHODS OF TESTING

Outdoor tests shall be performed according to **B-3.1**.

Indoor tests shall be performed according to **B-3.1**. Using the specifications of ISO 362-3 : 2016, variant A. For indoor application, the manufacturer shall provide to the technical service, documentation according to **E-1**. Variant A is a combination of indoor testing (power train sound) and outdoor testing (tyre/road sound).

B-3.1 Measurement of Sound of Vehicles in Motion

B-3.1.1 *General Conditions of Test*

For outdoor testing, two lines, *AA'* and *BB'*, parallel to line *PP'* and situated respectively (10 ± 0.05) m forward and (10 ± 0.05) m rearward of line *PP'* shall be marked out on the test runway.

For indoor testing, the virtual line *AA'* indicates the beginning of the test track, PP' indicates the virtual position of the two pass-by microphones, and BB' indicates the end of the test track. The simulated vehicle speed at *AA'* ($v_{AA'}$), or vehicle speed at *PP'* ($v_{PP'}$), is defined by the roller speed when the reference point of the vehicle passes the virtual line *AA'* or *PP'*, respectively. The simulated vehicle speed at *BB'* ($v_{BB'}$), is defined when the rear of the vehicle passes the virtual line *BB'*.

At least four measurements shall be made on each side of the vehicle and for each gear. Preliminary measurements may be made for adjustment purposes, but shall be disregarded.

The microphone shall be located at a distance of (7.5 ± 0.05) m from the reference line *CC'* of the track and (1.2 ± 0.02) m above the ground.

The reference axis for free field conditions (*see* IEC 61672-1 : 2002) shall be horizontal and directed perpendicularly towards the path of the vehicle line *CC'*.

B-3.1.2 *Specific Test Conditions for Vehicles*

B-3.1.2.1 *Vehicles of category M1, N1 and M2 ≤ 3 500 kg technically permissible maximum laden mass:*

The path of the centre line of the vehicle shall follow line *CC'* as closely as possible throughout the entire test, from the approach to line *AA'* until the rear of the vehicle passes line *BB'* + 20 m. If the vehicle is fitted with more than two-wheel drive, test it in the drives election which is intended for normal road use.

If the vehicle is fitted with an auxiliary manual transmission or a multi-gear axle, the position used for normal urban driving shall be used. In all cases, the gear ratios for slow movements, parking or braking shall be excluded.

The test mass of the vehicle shall be according to the Table 4 of **B-2.2.1**.

The test speed v_{test} is (50 ± 1) km/h. The test speed shall be reached, when the reference point is at line *PP'*.

If the test speed is modified according to **B-3.1.2.1.4.1** (d), the modified test speed shall be used for both the acceleration and constant speed test.

B-3.1.2.1.1 *Power to mass ratio index*

PMR (Power to Mass Ratio) is defined as follows:

$$PMR = (P_n/m_{ro}) \times 1\,000 \text{ kg/kW}$$

where

P_n = measured in kW; and
m_{ro} = measured in kg and defined according to **3.4**.

If two or more sources of propulsive power operate at the conditions of test specified in **B-3.1.2.1**, the total engine net power (P_n), shall be the arithmetic sum of parallel propulsive engines on the vehicle. Applicable parallel propulsive engines are those power sources which provide forward motion to the vehicle in combination at the conditions of test specified in **B-3.1.2.1** of Annex B to this standard. Specified power for non-combustion engines shall be the power stated by the manufacturer.

The PMR with no dimension is used for the calculation of acceleration.

B-3.1.2.1.2 *Calculation of acceleration*

Acceleration calculations are applicable to M1, N1 and M2 ≤ 3 500 kg technically permissible maximum laden mass categories only.

All accelerations are calculated using different speeds of the vehicle on the test track (*see* Annex B, Fig. 1). The formulae given are used for the calculation of $a_{wot\ (i)}$, $a_{wot\ (i\ +\ 1)}$ and $a_{wot\ test}$. The speed either at *AA'* or *PP'* is defined as the vehicle speed when the reference point passes *AA'* ($v_{AA'}$) or *PP'* ($v_{PP'}$). The speed at *BB'* is defined when the rear of the vehicle passes *BB'* ($v_{BB'}$). The method used for determination of the acceleration shall be indicated in the test report.

Due to the definition of the reference point for the vehicle the length of the vehicle (l_{veh}) is considered differently in the formula below. If the reference point is in the front of the vehicle, then $l = l_{veh}$, mid: $l = ½\, l_{veh}$ and rear: $l = 0$.

At the choice of the vehicle manufacturer, front engine vehicles may use l = 5 m, and mid-engine vehicles may use l = 2.5 m.

B-3.1.2.1.2.1 *Calculation procedure for vehicles with manual transmission, automatic transmission, adaptive transmissions and transmissions with continuous variable transmissions (CVT's) tested with locked gear ratios:*

$$a_{\text{wot test}} = [(v_{BB'}/3.6)^2 - (v_{AA'}/3.6)^2] / [2\times(20+l)]$$

$a_{\text{wot test}}$ used in the determination of gear selection shall be the average of the four $a_{\text{wot test (i)}}$ during each valid measurement run.

Pre-acceleration may be used. The point of depressing the accelerator before line *AA'* shall be reported in the Addendum to the Communication form (*see* Annex A).

B-3.1.2.1.2.2 *Calculation procedure for vehicles with automatic transmissions, adaptive transmissions and* (*CVT's*) *tested with non-locked gear ratios*

$a_{\text{wot test}}$ used in the determination of gear selection shall be the average of the four $a_{\text{wot test}}$, during each valid measurement run.

If devices or measures described in **B-3.1.2.1.4.2** can be used to control transmission operation for the purpose of achieving test requirements, calculate $a_{\text{wot test}}$ using the equation:

$$a_{\text{wot test}} = [(v_{BB'}/3.6)^2 - (v_{AA'}/3.6)^2] / [2\times(20+l)]$$

Pre-acceleration may be used. Pre-acceleration may be used. The point of depressing the accelerator before line AA' shall be reported in the Addendum to the communication form (*see* Annex A).

If devices or measures described in **B-3.1.2.1.4.2** are not used, calculate awot test using the equation:

$$a_{\text{wot test, PP-BB}} = ((v_{BB'}/3.6)^2 - (v_{PP'}/3.6)^2) / [2\times(10+l)]$$

Pre-acceleration shall not be used. The location of depressing the accelerator shall be where the reference point of the vehicle passes line AA'.

B-3.1.2.1.2.3 *Target acceleration*

The target acceleration aurban defines the typical acceleration in urban traffic and is derived from statistical investigations. This function depends on the PMR of a vehicle.

The target acceleration a_{urban} is defined by:

$$a_{\text{urban}} = 0.63 \times \log_{10}(\text{PMR}) - 0.09$$

B-3.1.2.1.2.4 *Reference Acceleration*

The reference acceleration $a_{\text{wot ref}}$ defines the required acceleration during the acceleration test on the test track. It is a function depending on the power-to-mass ratio of a vehicle. That function is different for specific vehicle categories.

The reference acceleration $a_{\text{wot ref}}$ is defined by:

$a_{\text{wot ref}} = 1.59 \times \log_{10}^{\text{PMR}} - 1.41$ for PMR ≥ 25
$a_{\text{wot ref}} = a_{\text{urban}} = 0.63 \times \log_{10}^{\text{PMR}} - 0.09$ for PMR < 25

B-3.1.2.1.3 *Partial power factor* (k_P)

The partial power factor k_P (*See* **B-3.1.3.1**) is used for the weighted combination of the test results of the acceleration test and the constant speed test for vehicles of category M1 and N1 and M2 ≤ 3 500 kg technically permissible maximum laden mass.

In cases other than a single gear test, $a_{\text{wot ref}}$ shall be used instead of $a_{\text{wot test}}$ (*see* **B-3.1.3.1**).

B-3.1.2.1.4 *Gear ratio selection*

The selection of gear ratios for the test depends on their specific acceleration potential a_{wot} under full throttle condition, according to the reference acceleration $a_{\text{wot ref}}$ required for the full throttle acceleration test.

If the vehicle allows different transmission setups like automatic or manual gear selection and/or has different software programs or modes (for example, sporty, winter, adaptive) leading to valid accelerations, the vehicle manufacturer shall prove to the satisfaction of the technical service, that the vehicle is tested in the mode which achieves an acceleration being closest to $a_{\text{wot ref}}$.

The vehicle transmission, gear, or gear ratio may be controlled by electronic or mechanical measures to avoid the activation of a kick-down function.

Fig. 2 to Fig. 6, give gear selection criteria and test run criteria for categories M1 and M2 having a technically permissible maximum laden mass not exceeding 3.500 kg and for category N1, in a flowchart form as an aid to test operation.

B-3.1.2.1.4.1 *Vehicles with manual transmission, automatic transmissions, adaptive transmissions or CVT's tested with locked gear ratios*

The following conditions for selection of gear ratios are possible:

a) If one specific gear ratio gives an acceleration in a tolerance band of ± 5 percent of the reference acceleration $a_{\text{wot ref}}$, not exceeding 2.0 m/s², test with that gear ratio;

b) If none of the gear ratios give the required acceleration, then choose a gear ratio (i), with an acceleration higher and a gear ratio (i+1), with an acceleration lower than the reference acceleration. If the acceleration value in gear ratio i does not exceed 2.0 m/s², use both gear ratios for the test. The weighting ratio in relation to the reference acceleration $a_{\text{wot ref}}$ is calculated by:

$$k = [a_{\text{wot ref}} - a_{\text{wot (i + 1)}}]/[a_{\text{wot (i)}} - a_{\text{wot (i + 1)}}]$$

c) If the acceleration value of gear ratio (i) exceeds 2.0 m/s², the first gear ratio shall be used that gives an acceleration below 2.0 m/s² unless gear ratio (i + 1) or [(i+2), or (i+3), or …] provides acceleration less than a_{urban}. In this case, two gears (i) and (i+1) [or (i+2), or (i+3), or …] shall be used, including the gear i with acceleration exceeding 2.0 m/s². In other cases, no other gear shall be used. The achieved acceleration $a_{\text{wot test}}$ during the test shall be used for the calculation of the part power factor k_P instead of $a_{\text{wot ref}}$;

d) If rated engine speed is exceeded in a gear ratio i before the vehicle passes *BB'* then external higher gear (i+1) shall be used. If then external higher gear (i+1) results in an acceleration below a_{urban}, the vehicle test speed, v_{test}, in the gear ratio i shall be reduced by 2.5 km/h and the gear ratio selection shall proceed as specified by the options given in this paragraph. In no case shall the vehicle test speed be reduced below 40 km/h;

e) If the rated engine speed is exceeded in gear ratio i before the vehicle passes *BB'* and the vehicle test speed is equal to 40 km/h, the higher gear ratio i+1 is allowed even if $a_{\text{wot test}}$ does not exceed a_{urban};

f) The vehicle test speed in the higher gear ratio (i+1) shall be 50 km/h; and

g) If no gear ratio is available with an acceleration below 2.0 m/s², the manufacturer shall, if possible take measures to avoid an acceleration value $a_{\text{wot test}}$ greater than 2.0 m/s².

Table 5 in Annex B provides examples for valid measures to control the downshift of gears or to avoid accelerations beyond 2.0 m/s². Any measure used by manufacturer for the above mentioned purposes shall be documented in the test report.

In the case of a vehicle not exempted from ASEP according to **7.3.2**, gear i shall be tested and values reported ($L_{\text{wot(i)}}$, $n_{\text{wot BBi}}$, $v_{\text{wot BBi}}$) in order to perform tests of Annex D.

B-3.1.2.1.4.2 *Vehicles with automatic transmission, adaptive transmissions and CVT's tested with non-locked gear ratios*

The gear selector position for full automatic operation shall be used.

The acceleration value a_{wot} test shall be calculated as defined in **B-3.1.2.1.2.2**.

The test may then include a gear change to a lower range and a higher acceleration. A gear change to a higher range and a lower acceleration is not allowed. A gear shifting to a gear ratio which is not used in urban traffic shall be avoided.

Therefore, it is permitted to establish and use electronic or mechanical devices, including alternate gear selector positions, to prevent a downshift to a gear ratio which is typically not used for the specified test condition in urban traffic.

The achieved acceleration $a_{\text{wot test}}$ shall be greater or equal to a_{urban}.

If possible, the manufacturer shall take measures to avoid an acceleration value $a_{\text{wot test}}$ greater than 2.0 m/s^2.

Table 5 in Annex B provides examples for valid measures to control the downshift of gears or to avoid accelerations beyond 2.0 m/s². Any measure used by manufacturer for the above-mentioned purposes shall be documented in the test report.

The achieved acceleration $a_{\text{wot test}}$ is then used for the calculation of the partial power factor k_P (*see* **B-3.1.2.1.3**) instead $a_{\text{wot ref}}$.

B-3.1.2.1.4.3 *Vehicles with only one gear ratio, like but not limited to Battery Electric Vehicles (BEV) and Fuel Cell Vehicles (FCV)*

The gear selector position for forward driving shall be used. The acceleration value $a_{\text{wot test}}$ shall be calculated as defined in **B-3.1.2.1.2.1**. The achieved acceleration $a_{\text{wot test}}$ shall be greater or equal to a_{urban}.

If possible, the manufacturer shall take measures to avoid an acceleration value $a_{\text{wot test}}$ greater than 2.0 m/s².

Table 5 in Annex B provides examples for valid measures to avoid accelerations beyond 2.0 m/s². Any measure used by manufacturer for the above mentioned purposes shall be documented in the test report.

The achieved acceleration $a_{\text{wot test}}$ is then used for the calculation of the partial power factor k_P (*see* **B-3.1.2.1.3**) instead $a_{\text{wot ref}}$.

B-3.1.2.1.5 *Acceleration test*

The manufacturer shall define the position of the reference point in front of line *AA'* of fully depressing the accelerator. The accelerator shall be fully depressed (as rapidly as is practicable) when the reference point of the vehicle reaches the defined point. The accelerator shall be kept in this depressed condition until the rear of the vehicle reaches line *BB'*. The accelerator shall then be released as rapidly as possible. The measurement reading shall not end before the rear of the vehicle is 20 m behind the *BB'* line. The point of fully depressing the accelerator shall be reported in Addendum to the Communication form (*see* Annex A). The Technical Service shall have the possibility of pretesting.

If the vehicle length was set according to the provisions of **B-3.1.2.1.2**. The accelerator shall be kept in the depressed condition until the reference point reaches *BB'* + 5 m for front engine vehicles, and *BB'* + 2.5 m for mid-engine vehicles.

In the case of articulated vehicles consisting of two non-separable units regarded as a single vehicle, the semi-trailer shall be disregarded in determining when line *BB'* is crossed.

B-3.1.2.1.6 *Constant speed test*

The constant speed test shall be carried out with the same gear(s) specified for the acceleration test and a constant speed of 50 km/h with a tolerance of ± 1 km/h between AA' and BB', or if applicable at the speed determined for the acceleration test according **B-3.1.2.1.4.1 (d)** with a tolerance of ± 1 km/h between AA' and BB'. During the constant speed test the acceleration control shall be positioned to maintain a constant speed between AA' and BB' as specified. If the gear is locked for the acceleration test, the same gear shall be locked for the constant speed test.

The constant speed test is not required for vehicles with a PMR < 25.

B-3.1.2.2 *Vehicles of categories M2 > 3 500* kg *Technically Permissible Maximum Laden Mass, M3, N2, N3*

The path of the centre line of the vehicle shall follow line CC' as closely as possible throughout the entire test, from the approach to line *AA'* until the rear of the vehicle passes line BB'. The test shall be conducted without a trailer or semi-trailer. If a trailer is not readily separable from the towing vehicle the trailer shall be ignored when considering the crossing of line BB'. If the vehicle incorporates equipment such as a concrete mixer, a compressor, etc, this equipment shall not be in operation during the test. The test mass of the vehicle shall be according to the Table 4 of **B-2.2.1** of Annex B to this standard.

The value of $n_{BB'}$ and $v_{BB'}$ used in the determination of gear and vehicle speed selection shall be the average of the four $n_{BB'}$, j and $v_{BB'}$, j values during each valid measurement run.

The value of $n_{BB'}$ shall be reported to a precision of 10 revolutions per minute. The reported $n_{BB'}$ shall be used in all subsequent calculation.

The value of $v_{BB'}$ shall be reported to the first digit after the decimal (xx.x). The reported $v_{BB'}$ shall be used in all subsequent calculation.

Target conditions of category M2 > 3 500 kg technically permissible maximum laden mass, N2:

When the reference point passes line *BB'*, the engine speed $n_{BB'}$ shall be between 70 percent and 74 percent of speed S, at which the engine develops its rated maximum net power, and the vehicle speed shall be (35 ± 5) km/h. Between line *AA'* and line *BB'* a stable acceleration condition according to definition **3.26.1** shall be ensured.

Target conditions of category M3, N3:

When the reference point passes line *BB'*, the engine speed $n_{BB'}$ shall be between 85 percent and 89 percent of speed S, at which the engine develops its rated maximum net power, and the vehicle speed shall be (35 ± 5) km/h. Between line *AA'* and line *BB'* a stable acceleration condition according to definition **3.26.1** shall be ensured.

B-3.1.2.2.1 *Gear ratio selection*

It shall be the responsibility of the manufacturer to determine the correct manner of testing to achieve the required conditions.

The vehicle transmission, gear, or gear ratio, shall be chosen to be able to fulfil the target conditions according to **B-3.1.2.2.1.1** or **B-3.1.2.2.1.2**. The vehicle transmission, gear, or gear ratio may be controlled by electronic or mechanical measures including exclusion of kick-down function.

Fig. 7 to Fig. 10 give gear selection criteria and test run criteria for categories M2 having a technically permissible maximum laden mass exceeding 3 500 kg, and for category N2, M3 and N3, in a flowchart as an aid to test operation.

B-3.1.2.2.1.1 *Manual transmission, automatic transmissions, adaptive transmissions or transmissions with continuously variable gear ratios (CVT's) tested with locked gear ratios*

Stable acceleration condition according to definition **3.26.1** shall be ensured. The gear choice is determined by the target conditions.

The following conditions for fulfilling the target conditions in **B-3.1.2.2**:

a) If one gear choice fulfils both target conditions for the rotational engine speed $n_{\text{target BB'}}$ and for the vehicle speed $v_{\text{target BB'}}$ test with that gear;

b) If more than one gear choice fulfils both target conditions for the rotational engine speed $n_{\text{target BB'}}$ and for the vehicle speed $v_{\text{target BB'}}$ test in gear i that gives velocity $v_{BB'}$ gear ratio i closest to 35 km/h;

c) If two gear choices fulfil both target conditions for the rotational engine speed $n_{\text{target BB'}}$ and for the vehicle speed $v_{\text{target BB'}}$ and fulfil the following condition;

$$[\, v_{\text{target BB'}} - v_{\text{BB' gear (i)}}] = [v_{\text{BB' gear (i+1)}} - v_{\text{target BB'}}]$$

Then both gears are taken for further calculation of L_{urban}.

d) If one gear choice fulfils the target condition for the rotational engine speed $n_{\text{target BB'}}$ but not the target condition for the vehicle speed $v_{\text{target BB'}}$ use two gears, gear$_x$ and gear$_y$.

The target conditions for the vehicle speed for these two gears are as follows:

gear$_x$ 25 km/h ≤ $v_{BB'x}$ ≤ 30 km/h and *gear*$_y$ 40 km/h ≤ $v_{BB'y}$ ≤ 45 km/h

Both gears, *gear*$_x$ and gear$_y$ shall fulfil the target rotational engine speed $n_{\text{target BB'}}$. Both gears shall be used for further calculation of L_{urban}.

If only one of the gears fulfils the target rotational engine speed $n_{\text{target BB'}}$ test with that gear. This gear shall be used for further calculation of L_{urban}.

e) If none of the two gears fulfils the target rotational engine speed $n_{\text{target BB'}}$ under condition (d) then condition (f) shall be chosen.

f) If no gear choice fulfils the target rotational engine speed choose the gear that fulfils the target vehicle velocity $v_{\text{target BB'}}$ and is closest to the target rotational engine speed $n_{\text{target BB'}}$, but not higher than $n_{\text{target BB'}}$.

$$v_{\text{BB' gear (i)}} = v_{\text{target BB'}}$$

$$n_{\text{BB' gear (i)}} \leq n_{\text{target BB'}}$$

A stable acceleration condition according to definition **3.26.1** shall be insured. If a stable acceleration cannot be insured in a gear, this gear shall be disregarded. In all conditions, the rated engine speed shall not be exceeded while the reference point of the vehicle is in the measurement zone. If the rated engine speed is exceeded within the measurement zone, this gear shall be disregarded.

B-3.1.2.2.1.2 *Automatic transmission, adaptive transmissions and transmissions with variable gear ratio tested with non-locked gear ratios*

The gear selector position for full automatic operation shall be used.

The test may then include a gear change to a lower range and a higher acceleration. A gear change to a higher range and a lower acceleration is not allowed. In any case a gear change to a gear ratio that is typically not used at the specified condition as defined by the manufacturer in urban traffic shall be avoided.

Therefore, it is permitted to establish and use electronic or mechanical devices, including alternative gear selector positions, to prevent a downshift to a gear ratio that is typically not used at the specified test condition as defined by the manufacturer in urban traffic.

Table 5 in Annex B provides examples for valid measures to control the downshift of gears. Any measure used by manufacturer for the above mentioned purposes shall be documented in the test report.

The following conditions for fulfilling the target conditions in **B-3.1.2.2** are possible:

a) If the choice of the gear selector position fulfils both target conditions for the rotational engine speed ($n_{\text{target BB'}}$) and for the vehicle speed ($v_{\text{target BB'}}$) test with the gear selector in that position.

b) If the choice of the gear selector position fulfils the target condition for the rotational engine speed ($n_{\text{target BB'}}$) but not the target condition for the vehicle speed ($v_{\text{target BB'}}$) change the target condition for the vehicle speed to two vehicle target speeds as follows:

Define $v_{\text{BB'1}}$ as : 25 km/h ≤ $v_{\text{BB'1}}$ ≤ 35 km/h; and
Define $v_{\text{BB'1}}$ as : 35 km/h ≤ $v_{\text{BB'2}}$ ≤ 45 km/h.

Conduct two tests, one with $v_{\text{BB'1}}$ and one with $v_{\text{BB'2}}$.

Both test conditions are used for further calculation of L_{urban}.

c) If under condition **B-3.1.2.2.1.2 (**b) the target rotational engine speed ($n_{\text{target BB'}}$) cannot be fulfilled, condition **B-3.1.2.2.1.2 (**d) shall be chosen.

d) If the choice of the gear selector position cannot fulfil the target condition for the rotational engine speed ($n_{\text{target BB'}}$) but the target condition for the vehicle speed ($v_{\text{target BB'}}$) change the target condition for the vehicle speed to two vehicle target speeds as follows:

Define $v_{\text{BB'1}}$ as : 25 km/h ≤ $v_{\text{BB'1}}$ ≤ 30 km/h; and

Define $v_{\text{BB'2}}$ as : 40 km/h ≤ $v_{\text{BB'2}}$ ≤ 45 km/h.

Conduct two tests, one with $v_{\text{BB'1}}$ and one with $v_{\text{BB'2}}$.

Use the test where $n_{\text{BB'}}$ is closest to the target rotational engine speed $n_{\text{target BB'}}$ but not higher than $n_{\text{target BB'}}$.

$n_{\text{BB'(i)}} \leq n_{\text{target BB'}}$ for i = 1, 2

If the vehicle cannot fulfil the condition:

$n_{\text{BB'(i)}} \leq n_{\text{target BB'}}$ for i = 1, 2 condition **B-3.1.2.2.1.2** (e) shall be used.

e) If the choice of the gear selector position cannot fulfil the target conditions for the rotational engine speed $n_{\text{target BB'}}$ and the target condition for the vehicle speed ($v_{\text{target BB'}}$) change the target condition for the vehicle speed to the following:

$$v_{\text{BB'}} = v_{\text{target BB'}} + 5 \text{ km/h}$$

Conduct the test with that vehicle speed $v_{\text{BB'}}$ where $n_{\text{BB'}}$ is closest to the target rotational engine speed ($n_{\text{target BB'}}$). A gear change to a higher range and a lower acceleration is allowed after the vehicle passes line *PP'*.

f) If the vehicle includes a transmission design that provides only a single gear selection (D) that limits engine speed during the test, the vehicle shall be tested using only the target vehicle speed ($v_{\text{target BB'}}$).

B-3.1.2.2.1.3 *Powertrain with no combustion engine rotational engine speed available*

Vehicles with a powertrain where no combustion engine rotational engine speed is available shall fulfil only the target condition for the vehicle speed (v_{target}BB').

The following conditions for fulfilling the target condition ($v_{\text{target BB'}}$) in **B-3.1.2.2** are possible:

a) If no rotational engine speed is available, it is necessary to fulfil only the target vehicle speed ($v_{\text{target BB'}}$).

b) If no rotational engine speed is available and the target vehicle speed ($v_{\text{target BB'}}$) cannot be fulfilled, two test conditions shall be conducted as follows:

   $v_{BB'1}$ for the first test condition is defined as 25 km/h $\leq v_{BB'1} \leq$ 35 km/h; and

   $v_{BB'2}$ for the second test condition is defined as 35 km/h $\leq v_{BB'2} \leq$ 45 km/h

   Both test conditions are used for further calculation of L_{urban}.

c) If no rotational engine speed is available and the target vehicle speed ($v_{\text{target BB'}}$) and $v_{BB'1}$ defined as:

   25 km/h $\leq v_{BB'1} \leq$ 35 km/h

   Cannot be fulfilled, it is necessary to conduct, only one test with $v_{BB'2}$ where $v_{BB'2}$ is defined as:

   35 km/h $\leq v_{BB'2} \leq$ 45 km/h

   The test condition for $v_{BB'2}$ is taken for further calculation of L_{urban}.

B-3.1.2.2.2 *Acceleration test*

When the reference point of the vehicle reaches the line *AA'* the accelerator control shall be fully depressed (without operating the automatic downshift to a lower range than normally used in urban driving) and held fully engaged until the reference point reaches *BB'* + 5 m. The acceleration control unit can then be released on request of the manufacturer.

In the case of articulated vehicles consisting of two non-separable units regarded as a single vehicle, the semi-trailer shall be disregarded in determining when line *BB'* is crossed.

B-3.1.3 *Interpretation of Results*

For vehicles of categories M1 and M2 having a maximum authorized mass not exceeding 3 500 kg, and category N1 the maximum A-weighted sound pressure level indicated during each passage of the vehicle according to **B-3.1.2.1.5** and **B-3.1.2.1.6** shall be rounded to the first significant digit after the decimal place (for example, XX.X).

For vehicles of category M2 having a maximum authorized mass exceeding 3 500 kg and categories M3, N2, and N3 the maximum A-weighted sound pressure level indicated during each passage of the reference point of the vehicle between line *AA'* and line *BB'* + 5 m shall be rounded, to the first significant digit after the decimal place (for example, XX.X).

For indoor testing, pass-by sound is simulated by measurement of power train sound on the tyre/road dynamometer and energetical addition of the sound (measured separately on an outdoor test track) according to **E-2**.

If a sound peak obviously out of character with the general sound pressure level is observed, the measurement shall be discarded. At least four measurements for each test condition shall be made on each side of the vehicle and for each gear ratio. Left and right side may be measured simultaneously or sequentially. The first four valid consecutive measurement results, within 2 dB (A), allowing for the deletion of non-valid results (*see* **B-2.1**), shall be used for the calculation of the final result for the given side of the vehicle. The results of each side shall be averaged separately and rounded to the first decimal place. All further calculations to derive L_{urban} shall be done separately for the left and right vehicle side. The final value to be reported as the test result mathematically rounded to the nearest integer shall be the higher value of the two sides.

The speed measurements at *AA'*, *BB'*, and *PP'* shall be noted and used in calculations to the first significant digit after the decimal place.

The calculated acceleration $a_{\text{wot test}}$ shall be noted to the second digit after the decimal place.

B-3.1.3.1 *Vehicles of categories M1, N1 and M2 ≤ 3 500 kg technically permissible maximum laden mass*

The calculated values for the acceleration test and the constant speed test are given by:

$$L_{\text{wot rep}} = L_{\text{wot(i +1)}} + k \times [L_{\text{wot(i)}} - L_{\text{wot(i +1)}}]\ L_{\text{crs rep}} = L_{\text{crs(i +1)}} + k \times [L_{\text{crs(i)}} - L_{\text{crs(i +1)}}]$$

where

$$k = [a_{\text{wot ref}} - a_{\text{wot (i + 1)}}] / [a_{\text{wot}}i - a_{\text{wot (i + 1)}}]$$

In the case of a single gear ratio test the values are the test result of each test. The final result is calculated by combining $L_{\text{wot rep}}$ and $L_{\text{crs rep}}$.

The equation is:

$$L_{\text{urban}} = L_{\text{wot rep}} - k_{\text{P}} \times (L_{\text{wot rep}} - L_{\text{crs rep}})$$

The weighting factor k_P gives the part power factor for urban driving. In cases other than a single gear test, k_P is calculated by:

$$k_{\text{P}} = 1 - (a_{\text{urban}} / a_{\text{wot ref}})$$

If only one gear was specified for the test, k_{P} is given by: $k_{\text{P}} = 1 - (a_{\text{urban}} / a_{\text{wot test}})$

In cases where $a_{\text{wot test}}$ is less than a_{urban} : $k_{\text{P}} = 0$.

B-3.1.3.2 *Vehicles of categories M2 > 3 500 kg technically permissible maximum laden mass, M3, N2, N3*

When the result of one test condition is used the final result L_{urban} is equal to the intermediate result.

When the results of two test conditions are used the arithmetic mean of the intermediate results of the two averages for each side of the two conditions shall be calculated. The final result L_{urban} is the higher value of the two calculated averages.

B-4 SOUND FROM THE HYBRID VEHICLE OF CATEGORIES M1 IN MOTION

Sound from the hybrid vehicle of categories M1 in motion, where an internal combustion engine cannot operate when the vehicle is stationary (data reported to facilitate testing of the vehicle in use).

B-4.1 In order to facilitate in-use compliance test of hybrid vehicles – where an internal combustion engine cannot operate when the vehicle is stationary, the following information relating to the sound-pressure level measurements carried out in accordance with **B-3.1** for the motor vehicles in motion is referred to as in-use compliance reference data:

a) Gear ratio (i) or, for vehicles tested with non-locked gear ratios, the position of the gear selector chosen for the test;

b) Position of the operating switch during measurement of the sound pressure level $L_{\text{wot(i)}}$(if switch is fitted);

c) The pre-acceleration length l_{pa} in m; and

d) The average vehicle speed in km/h at the beginning of the full throttle acceleration for tests in gear ratio (i); and

e) The sound pressure level $L_{\text{wot(i)}}$ in dB (A) of the wide-open-throttle tests in gear ratio i, defined as the maximum of the two values resulting from averaging the individual measurement results at each microphone position separately.

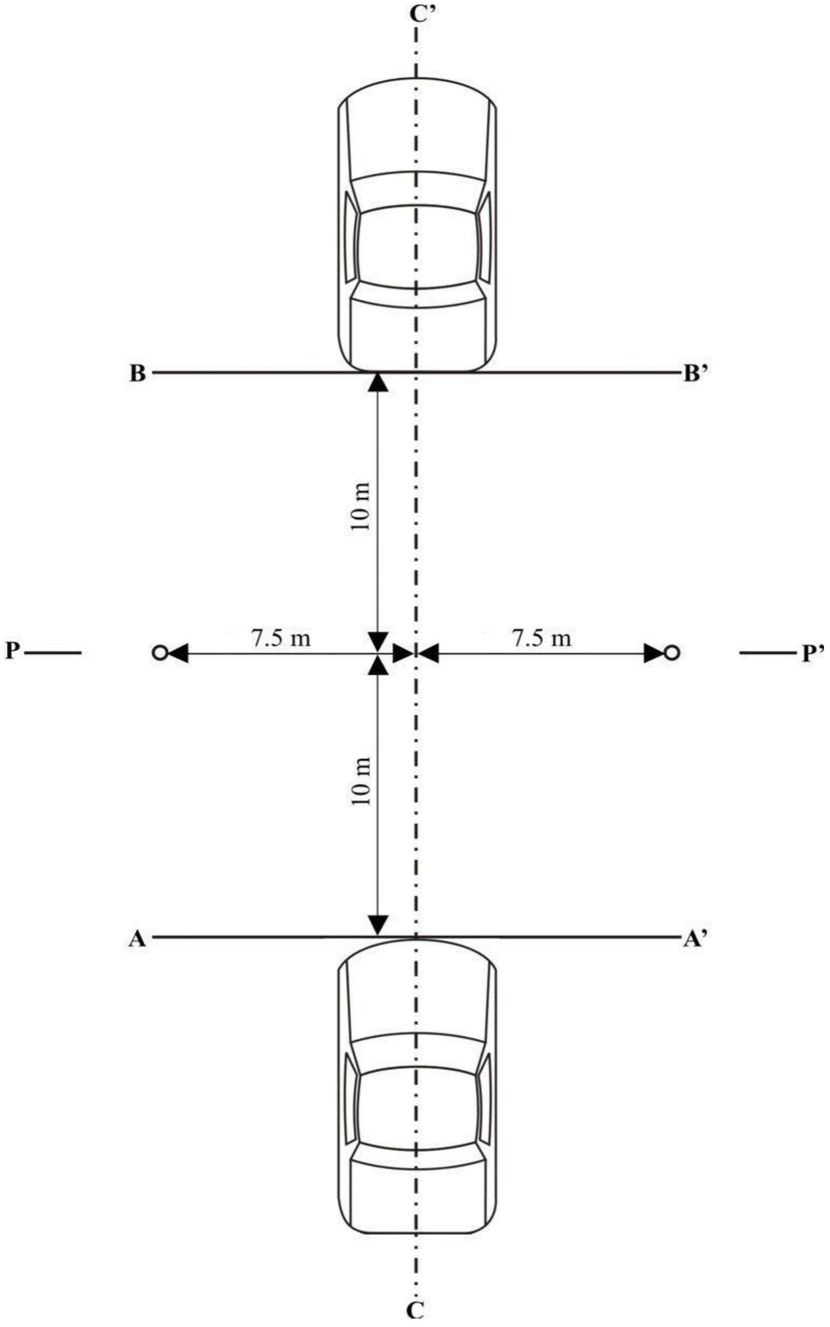


FIG. 1 MEASURING POSITIONS FOR VEHICLES IN MOTION

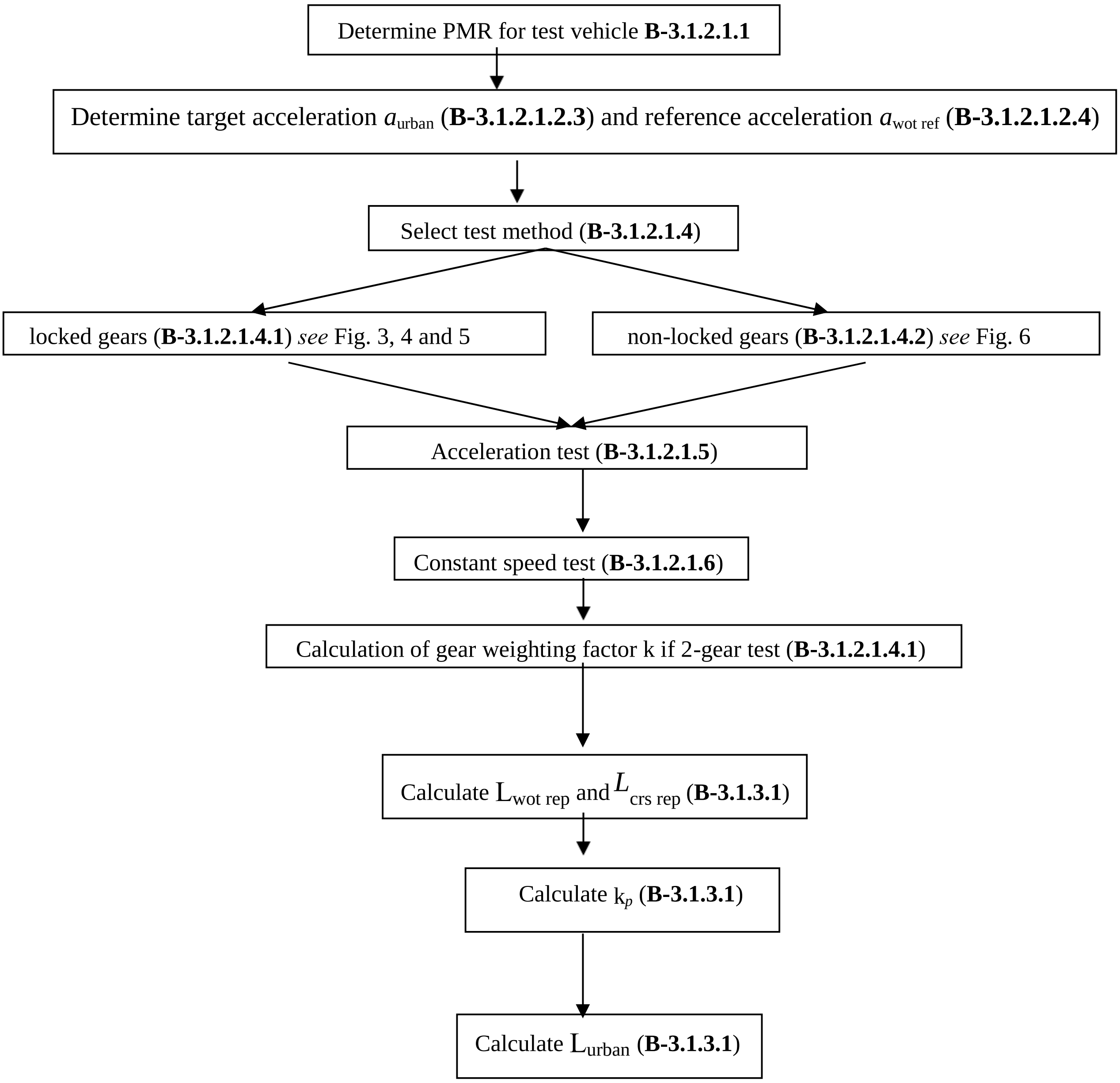

Determine PMR for test vehicle **B-3.1.2.1.1**
Determine target acceleration a_{urban} (**B-3.1.2.1.2.3**) and reference acceleration $a_{wot\ ref}$ (**B-3.1.2.1.2.4**)
Select test method (**B-3.1.2.1.4**)
locked gears (**B-3.1.2.1.4.1**) *see* Fig. 3, 4 and 5
non-locked gears (**B-3.1.2.1.4.2**) *see* Fig. 6
Acceleration test (**B-3.1.2.1.5**)
Constant speed test (**B-3.1.2.1.6**)
Calculation of gear weighting factor k if 2-gear test (**B-3.1.2.1.4.1**)
Calculate $L_{wot\ rep}$ and $L_{crs\ rep}$ (**B-3.1.3.1**)
Calculate k_p (**B-3.1.3.1**)
Calculate L_{urban} (**B-3.1.3.1**)

FIG. 2 FLOWCHART FOR VEHICLES TESTED ACCORDING TO **B-3.1.2.1** - L_{URBAN} COMPUTATION

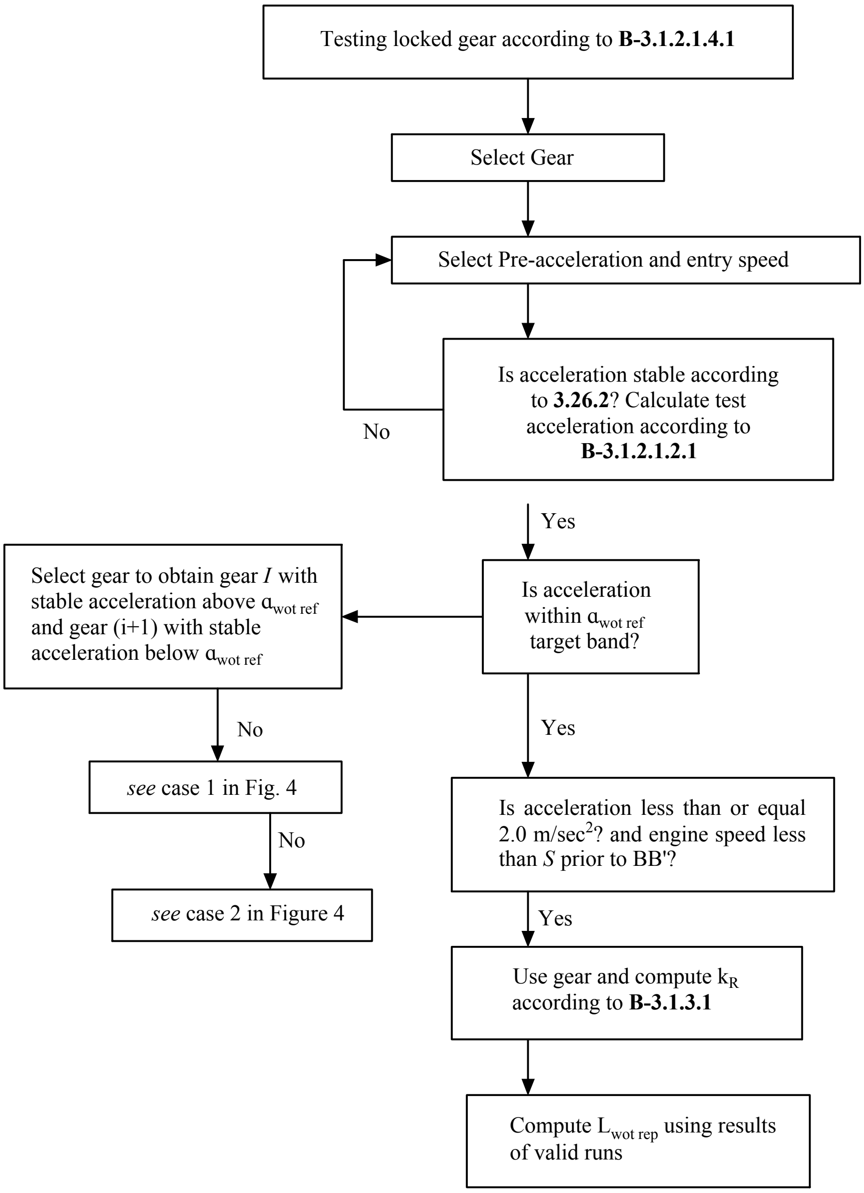

Testing locked gear according to **B-3.1.2.1.4.1**
Select Gear
Select Pre-acceleration and entry speed
Is acceleration stable according to **3.26.2**? Calculate test acceleration according to **B-3.1.2.1.2.1**
No
Yes
Select gear to obtain gear *I* with stable acceleration above $a_{wot\,ref}$ and gear (i+1) with stable acceleration below $a_{wot\,ref}$
Is acceleration within $a_{wot\,ref}$ target band?
No
Yes
see case 1 in Fig. 4
No
see case 2 in Figure 4
Is acceleration less than or equal 2.0 m/sec^2? and engine speed less than *S* prior to BB'?
Yes
Use gear and compute k_R according to **B-3.1.3.1**
Compute $L_{wot\,rep}$ using results of valid runs

FIG. 3 FLOWCHART FOR VEHICLE TESTED ACCORDING TO **B-3.1.2.1** - GEAR SELECTION USING LOCKED GEAR PART 1

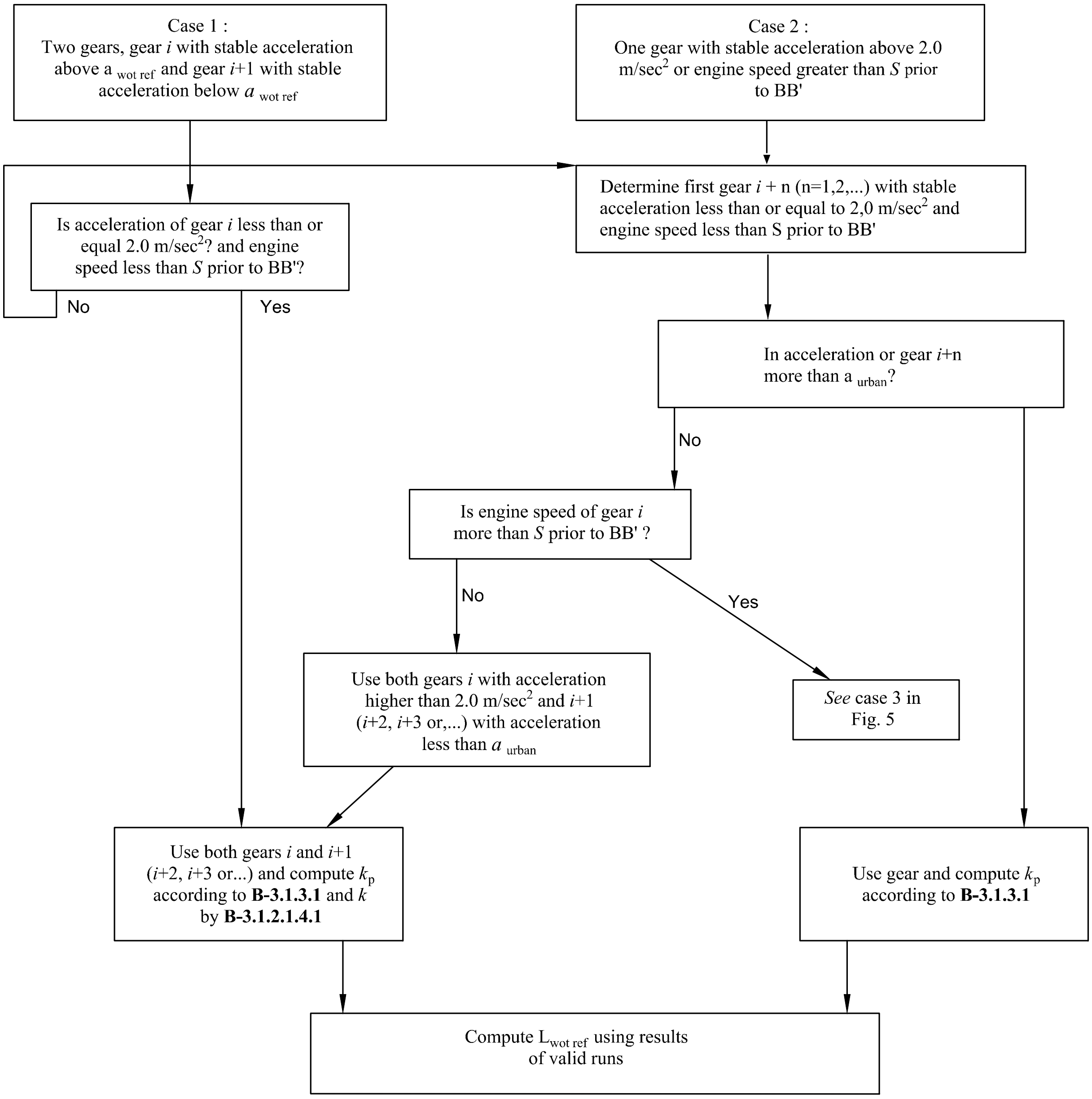

Case 1 :
Two gears, gear i with stable acceleration above $a_{\text{wot ref}}$ and gear i+1 with stable acceleration below $a_{\text{wot ref}}$
Case 2 :
One gear with stable acceleration above 2.0 m/sec^2 or engine speed greater than S prior to BB'
Determine first gear i + n (n=1,2,...) with stable acceleration less than or equal to 2,0 m/sec^2 and engine speed less than S prior to BB'
Is acceleration of gear i less than or equal 2.0 m/sec^2? and engine speed less than S prior to BB'?
No
Yes
In acceleration or gear i+n more than a_{urban}?
No
Is engine speed of gear i more than S prior to BB' ?
No
Yes
Use both gears i with acceleration higher than 2.0 m/sec^2 and i+1 (i+2, i+3 or,...) with acceleration less than a_{urban}
See case 3 in Fig. 5
Use both gears i and i+1 (i+2, i+3 or...) and compute k_p according to **B-3.1.3.1** and k by **B-3.1.2.1.4.1**
Use gear and compute k_p according to **B-3.1.3.1**
Compute $L_{\text{wot ref}}$ using results of valid runs

FIG. 4 FLOWCHART FOR VEHICLES TESTED ACCORDING TO **B-3.1.2.1** GEAR SELECTIONS USING LOCKED GEAR PART 2

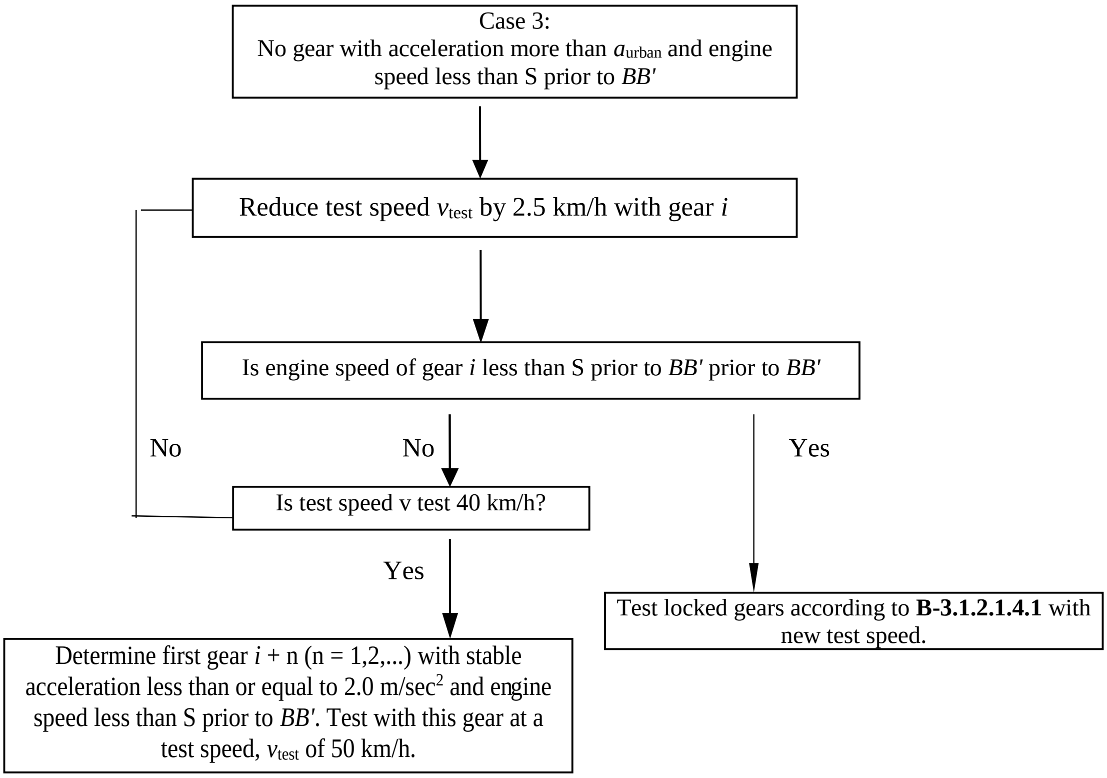

Case 3:
No gear with acceleration more than a_{urban} and engine speed less than S prior to *BB′*
Reduce test speed v_{test} by 2.5 km/h with gear *i*
Is engine speed of gear *i* less than S prior to *BB′* prior to *BB′*
No
No
Yes
Is test speed v test 40 km/h?
Yes
Test locked gears according to **B-3.1.2.1.4.1** with new test speed.
Determine first gear *i* + n (n = 1,2,...) with stable acceleration less than or equal to 2.0 m/sec^2 and engine speed less than S prior to *BB′*. Test with this gear at a test speed, v_{test} of 50 km/h.

FIG. 5 FLOWCHART FOR VEHICLES TESTED ACCORDING TO **B- 3.1.2.1** - GEAR SELECTION USING LOCKED GEAR PART 3

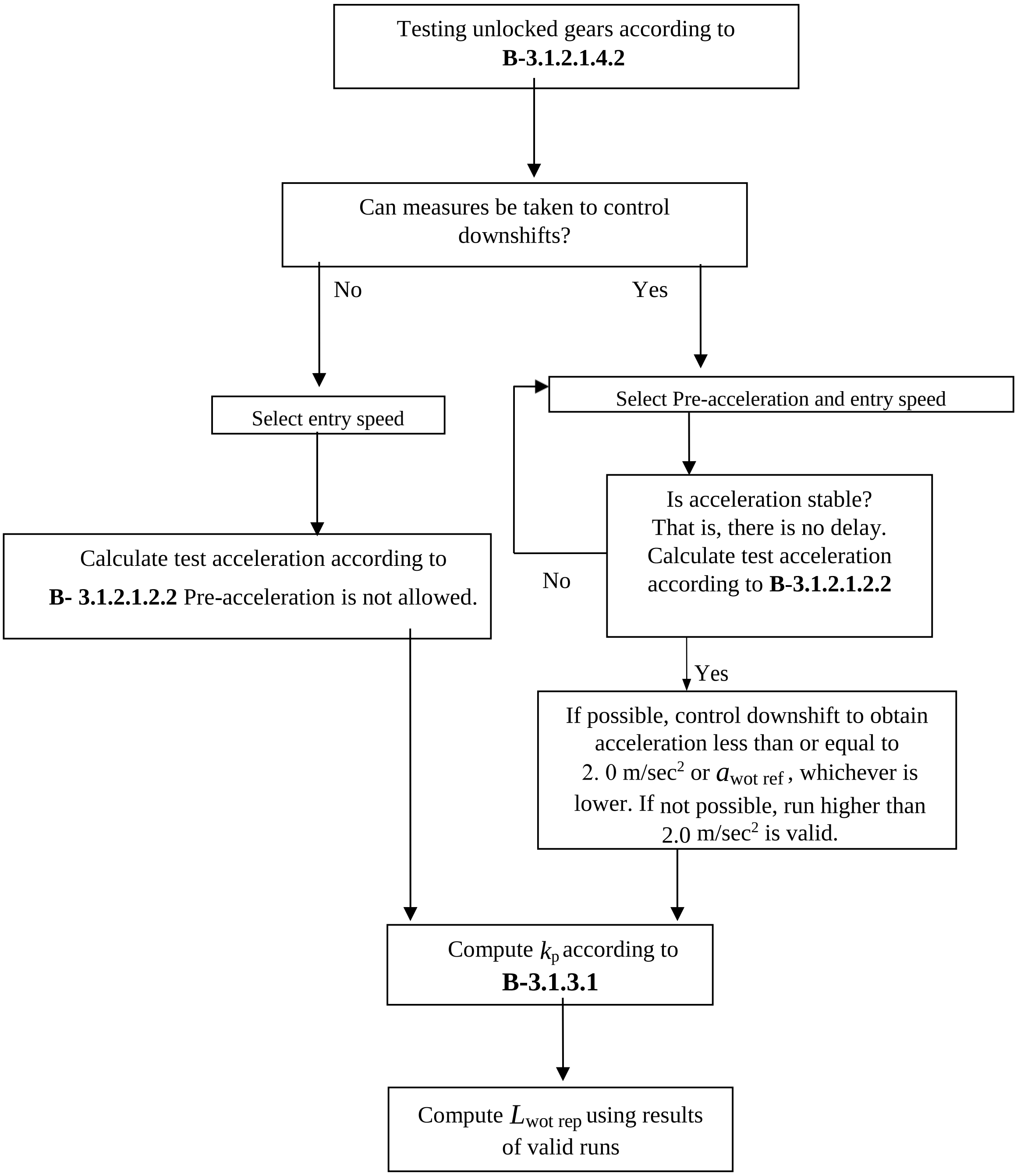

Testing unlocked gears according to **B-3.1.2.1.4.2**
Can measures be taken to control downshifts?
No
Yes
Select entry speed
Select Pre-acceleration and entry speed
Calculate test acceleration according to **B- 3.1.2.1.2.2** Pre-acceleration is not allowed.
Is acceleration stable? That is, there is no delay. Calculate test acceleration according to **B-3.1.2.1.2.2**
No
Yes
If possible, control downshift to obtain acceleration less than or equal to 2. 0 m/sec^2 or $a_{\text{wot ref}}$, whichever is lower. If not possible, run higher than 2.0 m/sec^2 is valid.
Compute k_p according to **B-3.1.3.1**
Compute $L_{\text{wot rep}}$ using results of valid runs

FIG. 6 FLOWCHART FOR VEHICLES TESTED ACCORDING TO **B-3.1.2.1** - GEAR SELECTION USING NON-LOCKED GEARS

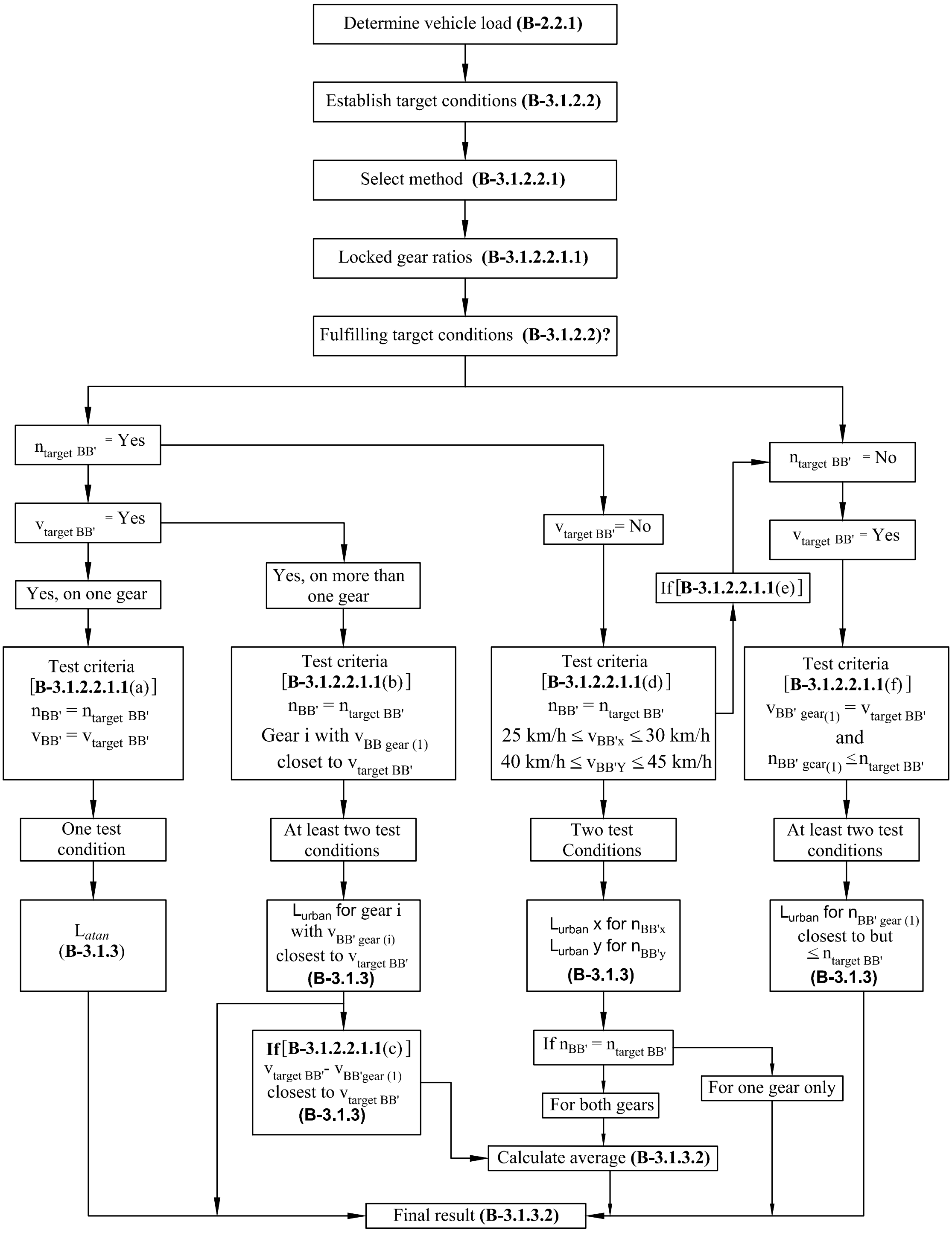

Determine vehicle load **(B-2.2.1)**
Establish target conditions **(B-3.1.2.2)**
Select method **(B-3.1.2.2.1)**
Locked gear ratios **(B-3.1.2.2.1.1)**
Fulfilling target conditions **(B-3.1.2.2)?**
$n_{target\ BB'}$ = Yes
$v_{target\ BB'}$ = Yes
Yes, on one gear
Yes, on more than one gear
$v_{target\ BB'}$ = No
$n_{target\ BB'}$ = No
$v_{target\ BB'}$ = Yes
If [**B-3.1.2.2.1.1**(e)]
Test criteria [**B-3.1.2.2.1.1**(a)] $n_{BB'} = n_{target\ BB'}$ $v_{BB'} = v_{target\ BB'}$
Test criteria [**B-3.1.2.2.1.1**(b)] $n_{BB'} = n_{target\ BB'}$ Gear i with $v_{BB\ gear\ (1)}$ closet to $v_{target\ BB'}$
Test criteria [**B-3.1.2.2.1.1**(d)] $n_{BB'} = n_{target\ BB'}$ 25 km/h ≤ $v_{BB'x}$ ≤ 30 km/h 40 km/h ≤ $v_{BB'Y}$ ≤ 45 km/h
Test criteria [**B-3.1.2.2.1.1**(f)] $v_{BB'\ gear(1)} = v_{target\ BB'}$ and $n_{BB'\ gear(1)} \leq n_{target\ BB'}$
One test condition
At least two test conditions
Two test Conditions
At least two test conditions
L_{atan} **(B-3.1.3)**
L_{urban} for gear i with $v_{BB'\ gear\ (i)}$ closest to $v_{target\ BB'}$ **(B-3.1.3)**
L_{urban} x for $n_{BB'x}$ L_{urban} y for $n_{BB'y}$ **(B-3.1.3)**
L_{urban} for $n_{BB'\ gear\ (1)}$ closest to but ≤ $n_{target\ BB'}$ **(B-3.1.3)**
If[**B-3.1.2.2.1.1**(c)] $v_{target\ BB'} - v_{BB'gear\ (1)}$ closest to $v_{target\ BB'}$ **(B-3.1.3)**
If $n_{BB'} = n_{target\ BB'}$
For both gears
For one gear only
Calculate average **(B-3.1.3.2)**
Final result **(B-3.1.3.2)**

FIG. 7 FLOWCHART FOR VEHICLES TESTED ACCORDING TO **B-3.1.2.2** - TEST IN LOCKED GEARS

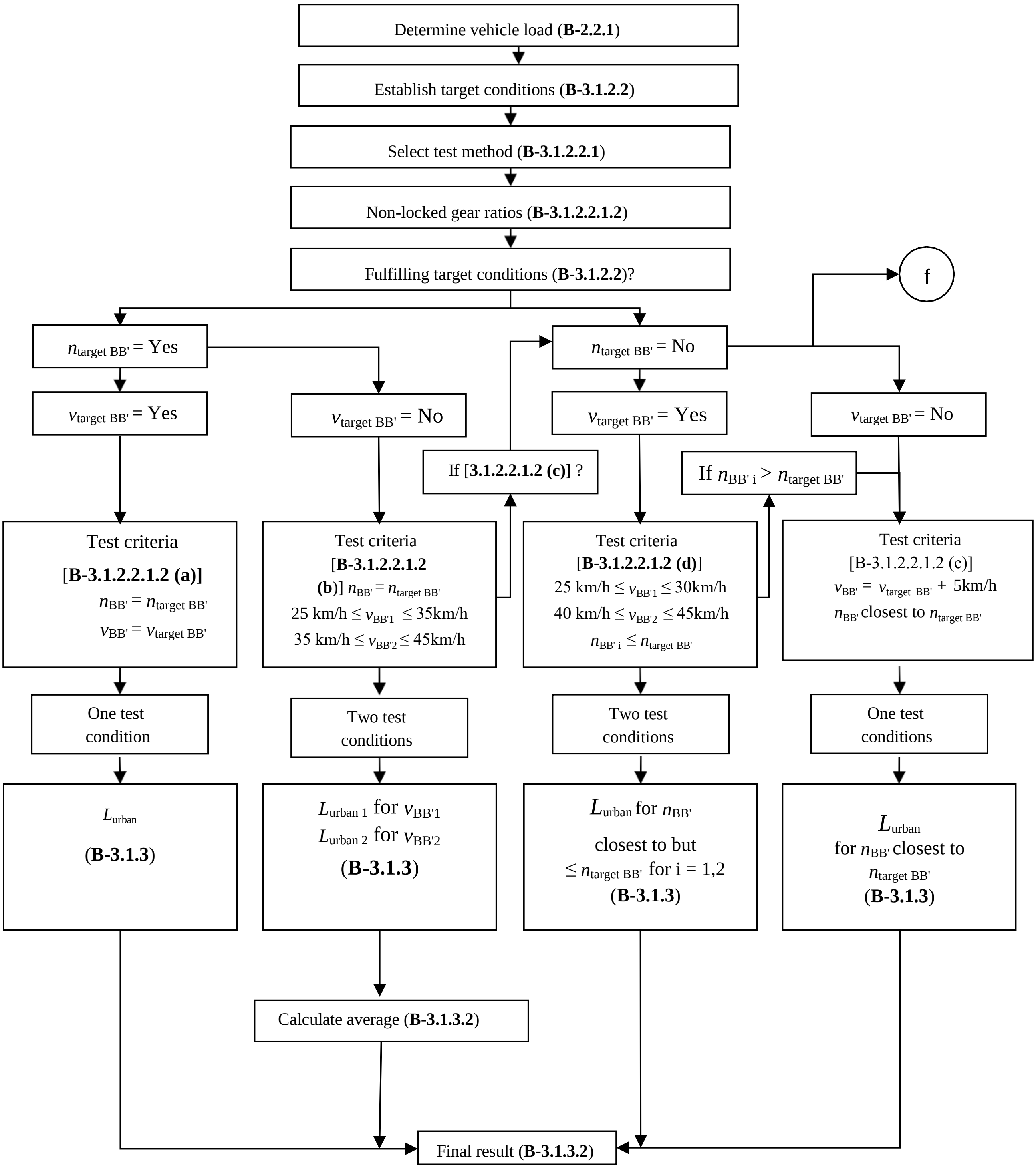

Determine vehicle load (**B-2.2.1**)
Establish target conditions (**B-3.1.2.2**)
Select test method (**B-3.1.2.2.1**)
Non-locked gear ratios (**B-3.1.2.2.1.2**)
Fulfilling target conditions (**B-3.1.2.2**)?
f
$n_{\text{target BB'}}$ = Yes
$v_{\text{target BB'}}$ = Yes
$v_{\text{target BB'}}$ = No
$n_{\text{target BB'}}$ = No
$v_{\text{target BB'}}$ = Yes
$v_{\text{target BB'}}$ = No
If [**3.1.2.2.1.2 (c)**] ?
If $n_{\text{BB' i}} > n_{\text{target BB'}}$
Test criteria [**B-3.1.2.2.1.2 (a)**] $n_{\text{BB'}} = n_{\text{target BB'}}$ $v_{\text{BB'}} = v_{\text{target BB'}}$
Test criteria [**B-3.1.2.2.1.2 (b)**] $n_{\text{BB'}} = n_{\text{target BB'}}$ 25 km/h $\leq v_{\text{BB'1}} \leq$ 35km/h 35 km/h $\leq v_{\text{BB'2}} \leq$ 45km/h
Test criteria [**B-3.1.2.2.1.2 (d)**] 25 km/h $\leq v_{\text{BB'1}} \leq$ 30km/h 40 km/h $\leq v_{\text{BB'2}} \leq$ 45km/h $n_{\text{BB' i}} \leq n_{\text{target BB'}}$
Test criteria [B-3.1.2.2.1.2 (e)] $v_{\text{BB'}} = v_{\text{target BB'}}$ + 5km/h $n_{\text{BB'}}$ closest to $n_{\text{target BB'}}$
One test condition
Two test conditions
Two test conditions
One test conditions
L_{urban} (**B-3.1.3**)
$L_{\text{urban 1}}$ for $v_{\text{BB'1}}$ $L_{\text{urban 2}}$ for $v_{\text{BB'2}}$ (**B-3.1.3**)
L_{urban} for $n_{\text{BB'}}$ closest to but $\leq n_{\text{target BB'}}$ for i = 1,2 (**B-3.1.3**)
L_{urban} for $n_{\text{BB'}}$ closest to $n_{\text{target BB'}}$ (**B-3.1.3**)
Calculate average (**B-3.1.3.2**)
Final result (**B-3.1.3.2**)

FIG. 8 FLOWCHART FOR VEHICLES TESTED ACCORDING TO **B- 3.1.2.2** - TEST IN NON-LOCKED GEARS PART 1

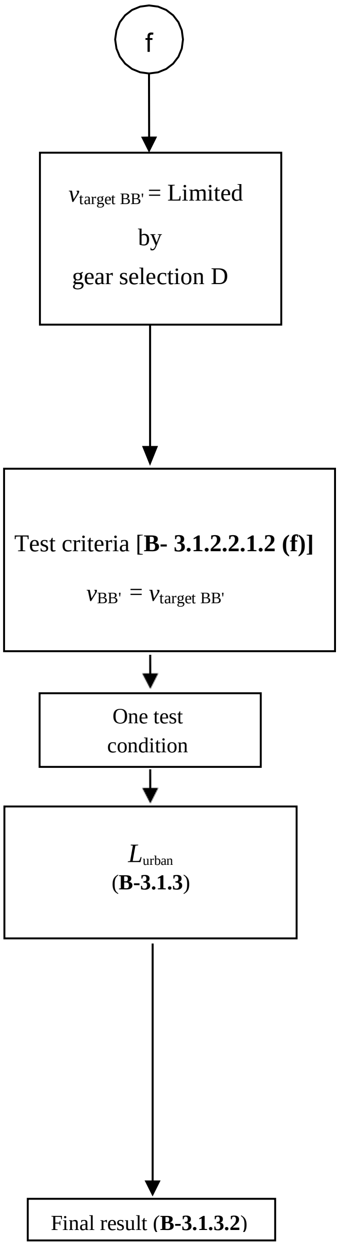

f
$v_{\text{target BB'}}$ = Limited by gear selection D
Test criteria [**B- 3.1.2.2.1.2 (f)]**
$v_{\text{BB'}} = v_{\text{target BB'}}$
One test condition
L_{urban}
(**B-3.1.3**)
Final result (**B-3.1.3.2**)

FIG. 9 FLOWCHART FOR VEHICLES TESTED ACCORDING TO **B-3.1.2.2** - TEST IN NON-LOCKED GEARS PART 2

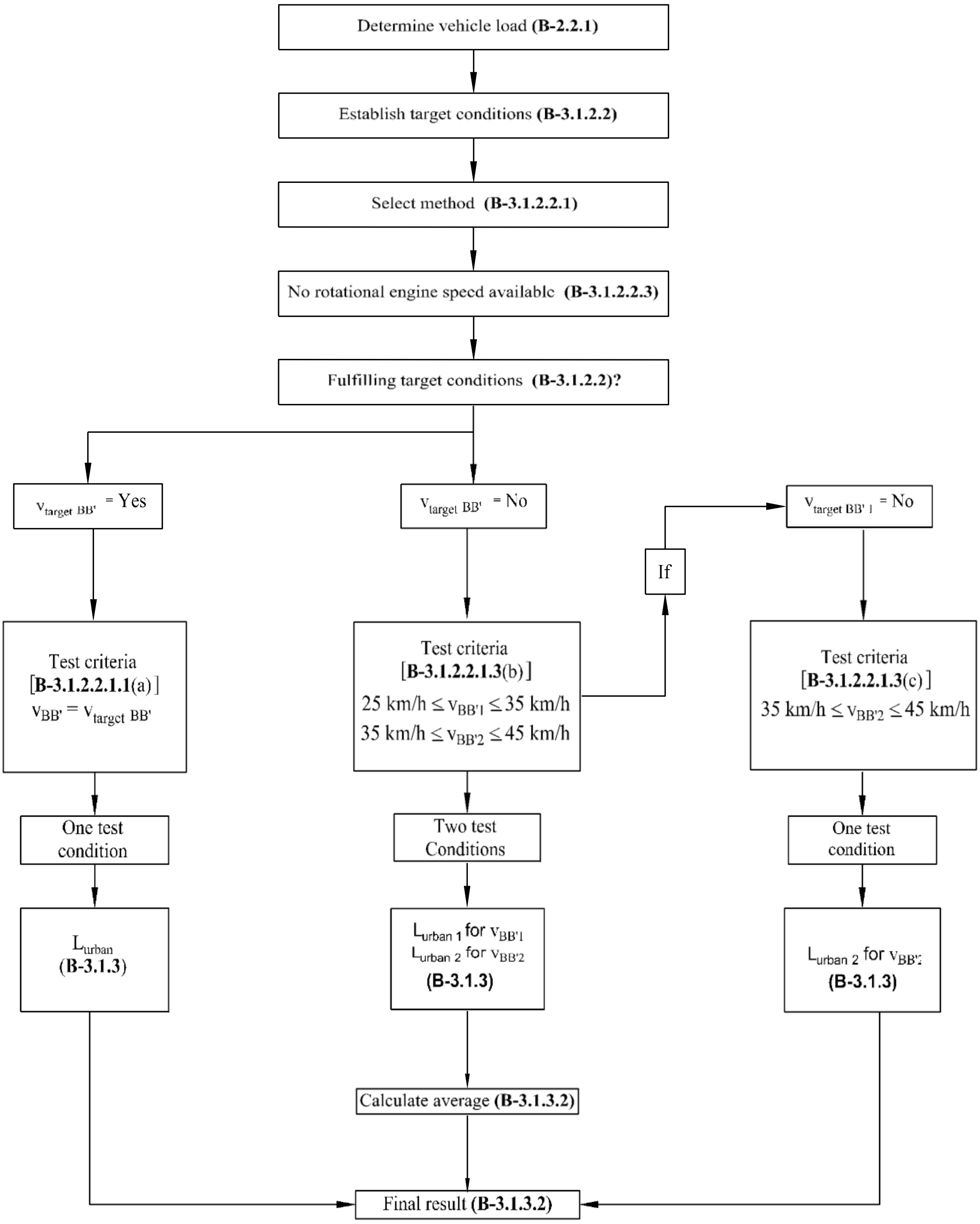

Determine vehicle load (B-2.2.1)
Establish target conditions (B-3.1.2.2)
Select method (B-3.1.2.2.1)
No rotational engine speed available (B-3.1.2.2.3)
Fulfilling target conditions (B-3.1.2.2)?
$v_{target\ BB'}$ = Yes
$v_{target\ BB'}$ = No
If
$v_{target\ BB'1}$ = No
Test criteria [B-3.1.2.2.1.1(a)]
$v_{BB'} = v_{target\ BB'}$
Test criteria [B-3.1.2.2.1.3(b)]
25 km/h ≤ $v_{BB'1}$ ≤ 35 km/h
35 km/h ≤ $v_{BB'2}$ ≤ 45 km/h
Test criteria [B-3.1.2.2.1.3(c)]
35 km/h ≤ $v_{BB'2}$ ≤ 45 km/h
One test condition
Two test Conditions
One test condition
L_{urban} (B-3.1.3)
$L_{urban\ 1}$ for $v_{BB'1}$
$L_{urban\ 2}$ for $v_{BB'2}$
(B-3.1.3)
$L_{urban\ 2}$ for $v_{BB'2}$
(B-3.1.3)
Calculate average (B-3.1.3.2)
Final result (B-3.1.3.2)

FIG. 10 FLOWCHART FOR VEHICLES TESTED ACCORDING TO **B-3.1.2.2** - TEST FOR NO COMBUSTION ENGINE SPEED AVAILABLE

NOTE — Broaden the window for the target vehicle speed $v_{\text{target BB'}}$ for vehicles of category M2 > 3 500 kg technically permissible maximum laden mass and for vehicles of category N2, M3 and N3.

The target vehicle velocity ($v_{\text{target BB'}}$) is defined as ($v_{\text{target BB'}}$ = 35 km/h ± 5 km/h) which results in a window for the velocity *BB'*, when the reference point passes line *BB'*, from 30 km/h to 40 km/h. If the target vehicle velocity $v_{\text{target BB'}}$ is changed into two target vehicle velocities, a lower and a higher one, the following is meant: The lower target vehicle velocity is defined as the target vehicle velocity (v_{target} BB') reduced by 5 km/h (v_{target} BB' - 5 km/h) which results in a window for the velocity vBB'1, when the reference point passes line BB', from 25 km/h to 35 km/h.

25 km/h ≤ vBB'1 ≤ 35 km/h.

The higher target vehicle velocity is defined as the target vehicle velocity ($v_{\text{target BB'}}$) increased by 5 km/h ($v_{\text{target BB'}}$ + 5 km/h) which results in a window for the velocity $v_{BB'2}$, when the reference point passes line *BB'*, from 35 km/h to 45 km/h (35 km/h ≤ $v_{BB'2}$ ≤ 45 km/h).

Table 5 Examples for Devices and Measures to Enable a Vehicle Tested within the Acceleration Boundaries

(*Clause* B-3.1.2.1.4.1, B-3.1.2.1.4.2, B-3.1.2.1.4.3, B-3.1.2.2.1.2, D-2.5.1)

Sl No.	**Impact**	**Sub No.**	**Measure**	**Additional Requirements**
(1)	(2)	(3)	(4)	(5)
i)	Lock of a discrete gear ratio	1*	A discrete gear ratio can be locked by the driver	None
		2	A discrete gear ratio is available onboard, but is not available to the driver. Locking can be activated by the manufacturer with an onboard (hidden) function or with an external device	None
ii)	Controlled gear shift	1*	Kickdown is deactivated	None
	management: Applicable to transmissions which cannot be locked, or where no locked gear provides a valid test result	2	Gear shift change(s) can happen during the test, gear shift is controlled by activation of an internal function or external device	Acceleration** shall be between aurban and $a_{\text{wot ref}}$, not exceeding 2.0 m/s².
iii)	Partial load driving****	1	Acceleration is limited by a mechanical device	Defined acceleration** shall be between aurban and $a_{\text{wot ref}}$, not exceeding 2.0 m/s². For ASEP**, the anchor point parameter are calculated by: $L_{\text{anchor}} = (L_{\text{test}} - k_P*L_{\text{crs}})/(1 - k_P)$ with $k_P = 1- a_{\text{test}}/a_{\text{wot ref}}$ and $a_{\text{wot ref}}$ according to **3.1.2.1.2.4** but not higher than 2.0 m/s² $n_{\text{anchor}} = n_{\text{BB', test}}* 3.6/v_{\text{BB', test}}*$ $[a_{\text{wot ref}} *(20 + 2*l) + 192.9]$ 0.5
		2	External Programming for partial load acceleration***)	

Table 5 (*Concluded*)

Sl No.	**Impact**	**Sub No.**	**Measure**	**Additional Requirements**
(1)	(2)	(3)	(4)	(5)
iv)	Mixed Solution (Mode): This measure will be a mix of the above solutions combined in a specific mode	1*	Mode is available onboard and can be selected by the driver	None
		2	Mode is available onboard and can only be activated by the manufacturer with a hidden function or an external device	None
		3	Mode is not available onboard, an external software overrides the internal software	Acceleration** shall be between a_{urban} and $a_{\text{wot ref}}$, not exceeding 2.0 m/s².

* Comment: This is a standard situation, already covered by the standard text.

** Applicable to vehicles of category M1, N1 and M2 ≤ 3 500 kg.

*** Partial load shall be achieved by simulation of the travel restriction of the accelerator. It is not allowed to interfere with the engine control management.

**** Applicable to vehicles of categories M1, N1 and M2 ≤ 3 500 kg, for the further calculation of L_{urban} in Annex B the sound level measured under partial load shall replace the sound level under wide open throttle.

The achieved acceleration under partial load during the test shall be used for the calculation of the part power factor k_P instead of $a_{\text{wot ref}}$.

The test procedure and the data processing follow the same principle. Although it is tested in partial load, symbols x_{wot} (for example, L_{wot}, a_{wot} …) shall be used.

ANNEX C

(*Clause* 7.3.2.4)

EXHAUST SILENCING SYSTEMS CONTAINING ACOUSTICALLY ABSORBING FIBROUS MATERIALS

C-1 GENERAL

Sound absorbing fibrous materials may be used in silencing systems or components thereof only if:

a) The exhaust gas is not in contact with the fibrous materials; or if

b) The silencing system or components thereof are of the same design family as systems or components for which it has been proven, in the course of type approval process in accordance with the requirements of this standard for another vehicle-type, that they are not subject to deterioration.

Unless one of these conditions is fulfilled, the complete silencing system or components thereof shall be submitted to a conventional conditioning using one of three installations and procedures described below, or on request of the manufacturer by removing the fibrous materials from the silencer.

C-1.1 Continuous Road Operation for 10 000 km

C-1.1.1 (50 ± 20) percent of this operation shall consist of urban driving and the remaining operation shall be long distance runs at high speed; continuous road operation may be replaced by a corresponding test-track programme.

C-1.1.2 The two speed regimes shall be alternated at least twice.

C-1.1.3 The complete test programme shall include a minimum of 10 breaks of at least three hours duration in order to reproduce the effects of cooling and any condensation which may occur.

C-1.2 Conditioning on a Test Bench

C-1.2.1 Using standard parts and observing the vehicle manufacturer's instructions, the silencing system or components thereof shall be fitted to the vehicle or the engine referred in the note below. In the former case, the vehicle shall be mounted on a roller dynamometer. In the second case, the engine shall be coupled to a dynamometer.

NOTE — The single vehicle, representative of the type in question, will be selected by the test agency conducting approval tests, in accordance with the vehicle manufacturer, as that with the lowest mass in running order with the shortest length and following the specification laid down in **B-3.1.2.2**.

At the request of the test agency conducting type approval tests, the vehicle manufacturer shall, in addition, submit a sample of the sound reduction system and an engine of at least the same cylinder capacity and rated maximum net power as that fitted to the vehicle in respect of which type approval is sought.

C-1.2.2 The test shall be conducted in six six-hour periods with a break of at least 12 hours between each period in order to reproduce the effects of cooling any condensation which may occur.

C-1.2.3 During each six-hour period, the engine shall be run, under the following conditions:

a) Five minutes at idling speed;

b) One-hour sequence under ¼ load at ¾ of rated maximum speed (*S*);

c) One-hour sequence under ½ load at ¾ of rated maximum speed (S);

d) 10-minute sequence under full load at ¾ of rated maximum speed (S);

e) 15-minute sequence under ½ load at rated maximum speed (S); and

f) 30-minute sequence under ¼ load at rated maximum speed (*S*).

Each period shall comprise two sequenced sets of the six above-mentioned conditions in consecutive order from (a) to (f).

C-1.2.4 During the test, the silencing system or components thereof shall not be cooled by a forced draught simulating normal airflow around the vehicle. Nevertheless, at the request of the manufacturer, the silencing system or components thereof may be cooled in order not to exceed the temperature recorded at its inlet when the vehicle is running at maximum speed.

C-1.3 Conditioning by Pulsation

C-1.3.1 The silencing system or components thereof shall be fitted to the vehicle or the engine referred in the note below. In the former case the vehicle shall be mounted on a roller dynamometer.

In the second case, the engine shall be mounted on a dynamometer. The test apparatus, a detailed diagram of which is shown in Fig. 11 to this annex, shall be fitted at the outlet of the silencing system. Any other apparatus providing equivalent results is acceptable.

NOTE — The single vehicle, representative of the type in question, will be selected by the test agency conducting approval tests, in accordance with the vehicle manufacturer, as that with the lowest mass in running order with the shortest length and following the specification laid down in **B-3.1.2.2**.

At the request of the test agency conducting type approval tests, the vehicle manufacturer shall, in addition, submit a sample of the sound reduction system and an engine of at least the same cylinder capacity and rated maximum net power as that fitted to the vehicle in respect of which type approval is sought.

C-1.3.2 The test apparatus shall be adjusted in such a way that the exhaust-gas flow is alternatively interrupted and re-established by the quick-action valve for 2 500 cycles.

C-1.3.3 The valve shall open when the exhaust-gas back pressure, measured at least 100 mm downstream of the intake flange, reaches a value of between 35 and 40 kPa. It shall close when this pressure does not differ by more than 10 percent from its stabilized value with the valve open.

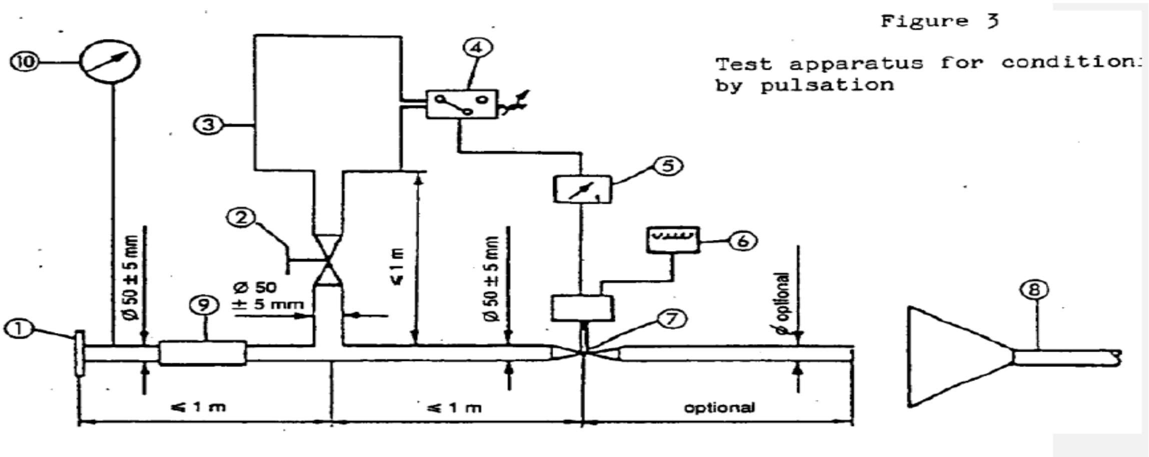
C-1.3.4 The time-delay switch shall be set for the duration of gas exhaust resulting from the provisions laid down in **C-1.3.3**.

C-1.3.5 Engine speed shall be 75 percent of the rated engine speed (*S*) at which the engine develops rated maximum net power.

C-1.3.6 The power indicated by the dynamometer shall be 50 percent of the full-throttle power measured at 75 percent of rated engine speed (*S*).

C-1.3.7 Any drain holes shall be closed off during the test.

C-1.3.8 The entire test shall be completed within 48 h. If necessary, one cooling period will be observed after each hour.



Key

1 = Inlet flange or sleeve for connection to the rear of the test exhaust system;

2 = Hand-operated regulating valve;

3 = Compensating reservoir with a maximum capacity of 40 L and a filling time of not less than one second;

4 = Pressure switch with an operating range of 0.05 to 2.5 bar;

5 = Time delay switch;

6 = Pulse counter;

7 = Quick-acting valve, such as exhaust brake valve 60 mm in diameter, operated by a pneumatic cylinder with an output of 120 N at 4 bar. The response time, both when opening and closing, shall not exceed 0.5second;

8 = Exhaust gas evacuation;

9 = Flexible pipe; and

10 = Pressure gauge.

FIG. 11 TEST APPARATUS FOR CONDITIONING BY PULSATION

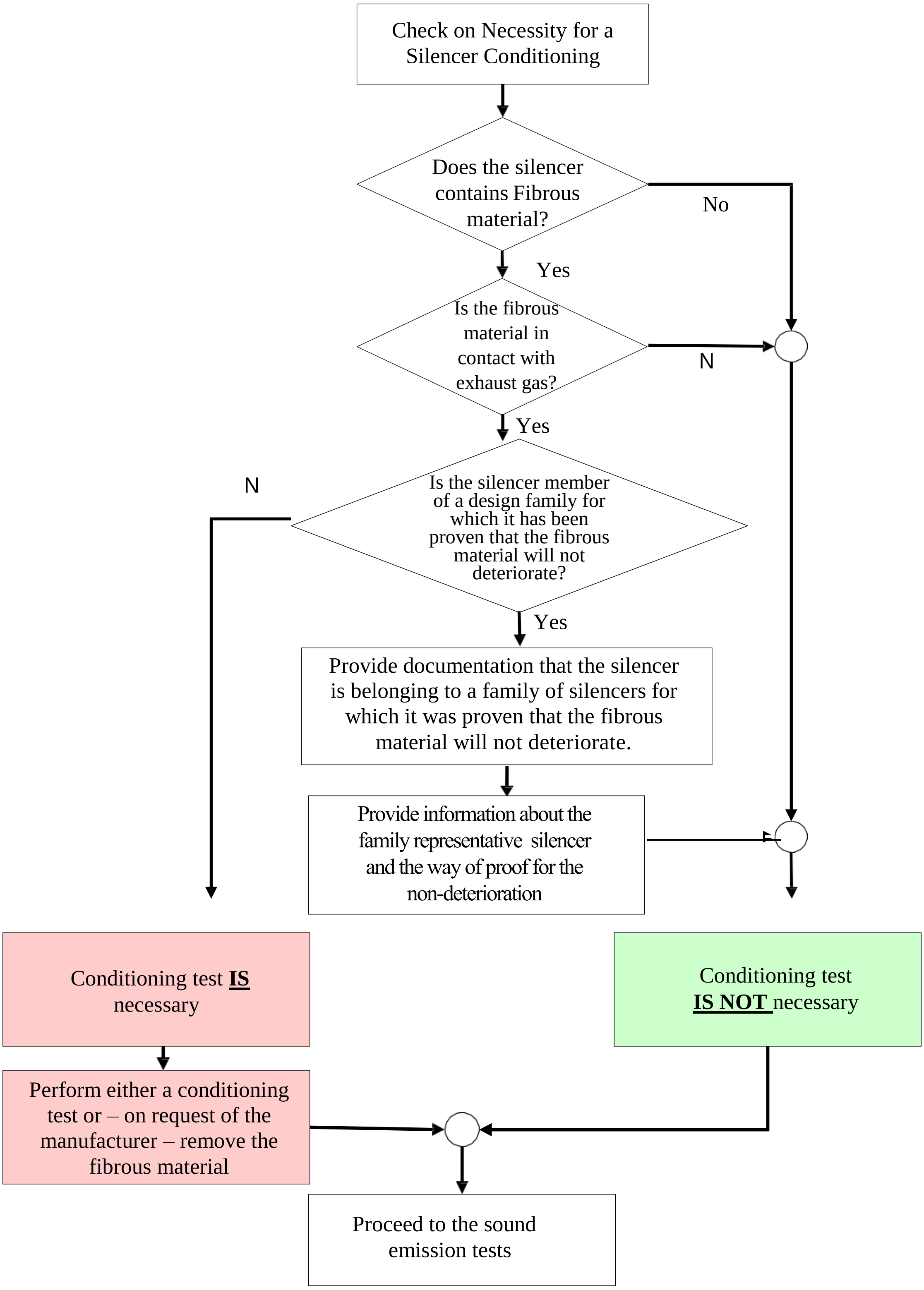

Check on Necessity for a Silencer Conditioning
Does the silencer contains Fibrous material?
No
Yes
Is the fibrous material in contact with exhaust gas?
N
Yes
N
Is the silencer member of a design family for which it has been proven that the fibrous material will not deteriorate?
Yes
Provide documentation that the silencer is belonging to a family of silencers for which it was proven that the fibrous material will not deteriorate.
Provide information about the family representative silencer and the way of proof for the non-deterioration
Conditioning test IS necessary
Conditioning test IS NOT necessary
Perform either a conditioning test or – on request of the manufacturer – remove the fibrous material
Proceed to the sound emission tests

FIG. 12 FLOWCHART FOR THE CHECK ON THE NECESSITY FOR A SILENCER CONDITIONING TEST

ANNEX D

(*Clause* 7.3.2)

MEASURING METHOD TO EVALUATE COMPLIANCE WITH THE ADDITIONAL SOUND EMISSION PROVISIONS (OPTIONAL)

D-1 GENERAL (*see* the Flowchart in Fig. 13)

This annex describes a measurement method to evaluate compliance of the vehicle with the additional sound emission provisions (ASEP) conforming to **7.3.2**.

It is not mandatory to perform actual tests when applying for type-approval. The manufacturer shall sign the declaration of compliance set out in **D-5.5**. The approval authority may ask for additional information about the declaration of compliance and carry out the tests described below.

The procedure set out in this annex requires the performance of a test in accordance with Annex B.

If the tests according to Annex D are carried out in the course of type approval, all tests either for Annex B and for Annex D shall be carried out on the same test track and under similar environmental conditions.

NOTE — Measurements for Annex D for a particular vehicle type may be carried out on a different test tracks or under different environmental conditions, each according to the provisions of this standard, if the test results $L_{wot(i)}$ and $L_{crs(i)}$ for the geari, representing the anchor point, do not differ by more the +/- 1.0 dB from the test results at the time when the tests according to Annex B have been carried out.

If Annex D tests are carried out when type approval has already been granted, e.g. during tests for conformity of production or for in-use compliance, the tests in motion specified in Annex B shall be carried out with the same mode, gear(s)/gear ratio(s), gear weighting factor k and partial power factor k_P as determined during the type approval process.

D-2 MEASUREMENT METHOD (*see* the flowchart in Fig. 15

D-2.1 Measurement Instruments and Condition of Measurements

Unless otherwise specified, the measurement instruments, the conditions of the measurements and the condition of the vehicle are equivalent to those specified in **B-1** and **B-2**.

If the vehicle has different modes which affect sound emission, all modes shall comply with the requirements in this annex. In the case where the manufacturer has performed tests to prove to the approval authority compliance with the above requirements, the modes used during those tests shall be reported in a test report.

D-2.2 Method of Testing

Unless otherwise specified, the conditions and procedures of Annex B shall be used. For the purpose of this annex, one run per test condition is measured and evaluated.

D-2.3 Control Range

The ASEP requirements apply to every gear ratio κ that leads to test results within the control range as defined below.

Vehicle speed $v_{AA'\_ASEP}$:	$v_{AA} \geq 20$ km/h Vehicle acceleration
a_{wot_ASEP} :	$a_{wot} \leq 5.0 m/s^2$
Engine speed n_{BB_ASEP}:	$n_{BB} \leq 2.0 \times PMR^{-0.222} \times$Sor
Vehicle speed $v_{BB'\_ASEP}$:	$n_{BB} \leq 0.9 \times S$, whichever is the lowest

If the vehicle in the lowest valid gear does not achieve the maximum engine speed n_{BB_ASEP} below 70 km/h, increase the vehicle speed in that gear to reach the maximum engine speed n_{BB_ASEP}, but not beyond 80km/h.

For any other gear, the maximum vehicle speed is For vehicles tested in non-locked transmission conditions, the maximum vehicle speed is 80 km/h. Gears κ ≤ gear i as determined in Annex B transmission conditions:

Annex B gear selection	Annex D gear selection
Locked	Gear i, gear (i-1),…
Non-locked	Non-locked

D-2.4 Target conditions

The sound emission shall be measured in each valid gear ratio at the four test points as specified below. For all test points the boundary conditions as specified in **D-2.3** shall be met.

The gear ratio is valid if all four points and the anchor point meet the specifications of **D-2.3**. Any gear ratio for which this criteria is not fulfilled is invalid and not analyzed further.

The first test point P1 is defined by using an entry speed $v_{AA,\ \kappa 1}$ of 20 km/h ≤ $v_{AA\_\kappa 1}$ < 20 km/h + 3 km/h.

For P1, if a stable acceleration condition according to the definition of **3.26.1** cannot be achieved, the speed $v_{AA,\ \kappa 1}$ shall be increased in steps of 5 km/h until a stable acceleration is reached.

For all points, stable acceleration according to the definition of **3.26.3** shall be verified by comparing the acceleration $a_{\text{wot test, AA-BB}}$ calculated between line. *AA'* and line *BB'* with the acceleration $a_{\text{wot test, PP-BB}}$ calculated between line *PP'* and *BB'*.

If the ratio $a_{\text{wot test, PP-BB}}/a_{\text{wot test, AA-BB}}$ does not exceed or is equal to 1.20, then proceed with the acceleration calculation between line *AA'* and Line *BB'*.

If the ratio $a_{\text{wot test, PP-BB}}/a_{\text{wot test, AA-BB}}$ does exceed 1.20, then proceed with the acceleration calculation between line *PP'* and line *BB'*.

In case of non-locked transmission conditions where n_{BB_ASEP} is exceeded during the test, the following measures shall be considered separately or together:

a) Provisions of **D-2.5.1**; and

b) Increased speed in steps of 5 km/h.

The test speed for the fourth test point P4 in any gear is defined by either:

a) 0.95 x $n_{BB\_ASEP} \leq n_{BB,\ \kappa 4} \leq n_{BB\_ASEP}$; or

b) $v_{BB'\_ASEP}$ - 3 km/h ≤ $v_{BB,\ \kappa 4} \leq v_{BB'\_ASEP}$ with $v_{BB'\_ASEP}$ as defined in **D-2.3**.

The test speed for the other two test points is defined by the following formula:

Test Point Pj : $v_{BB,\ \kappa j} = v_{BB,\ \kappa 1} + ((j - 1)/3) \times (v_{BB,\ \kappa 4} - v_{BB,\ \kappa 1})$ for j = 2 and 3 with a tolerance of ± 3 km/h

where

$v_{BB,\ \kappa 1}$ = Vehicle speed at BB' of test point P1; and
$v_{BB,\ \kappa 4}$ = Vehicle speed at BB' of test point P4

D-2.5 Test of the Vehicle

D-2.5.1 The path of the centerline of the vehicle shall follow line *CC'* as closely as possible throughout the entire test, starting from the approach of the reference point according to definition **3.11** of the main body to line *AA'* until the rear of the vehicle passes line *BB'*.

At line *AA'* the accelerator shall be fully depressed. To achieve a more stable acceleration according definition **3.26.2** or to avoid a downshift between line *AA'* and *BB'* pre-acceleration before line *AA'* may be used according to **B-3.1.2.1.2.1** and **B-3.1.2.1.2.2**. The accelerator shall be kept in depressed condition until the rear of the vehicle reaches line BB'.

In case of non-locked transmission conditions, the test may include a gear ratio change to a lower range and a higher acceleration. A gear change to a higher range and a lower acceleration is not allowed.

If possible, the manufacturer shall take measures to avoid that a gearshift leads to a condition not in compliance with the boundary conditions. For that, it is permitted to establish and use electronic or mechanical devices, such as alternate gear selector positions. If no such measures can be applied, the rationale shall be provided and documented in the technical report.

Table 5 in Annex B provides examples for valid measures to control the downshift of gears. Any measure used by manufacturer for the above-mentioned purposes shall be documented in the test report.

D-2.5.2 Measurements Reading

D-2.5.2.1 For every test point, one single run shall be carried out.

D-2.5.2.2 For every separate test run, the following parameters shall be determined and noted:

D-2.5.2.3 The maximum A-weighted sound pressure level of both sides of the vehicle, indicated during each passage of the vehicle, according to **B-3.1.2.1.5** shall be mathematically rounded to the first decimal place ($L_{\text{wot, κj}}$). If a sound peak obviously out of character with the general sound pressure level is observed, the measurement shall be discarded. Left and right side may be measured simultaneously or separately. For further processing, the higher sound pressure level of both sides shall be used.

The vehicle speed readings at *AA'*, *PP'* and *BB'* shall be rounded and reported with the first significant digit after the decimal place. ($v_{\text{AA,κj}}$; $v_{\text{PP,κj}}$; $v_{\text{BB,κj}}$)

If applicable, the engine speed readings at *BB'* shall be reported as a full integer value ($n_{\text{BB, κj}}$).

D-2.5.3 The calculated acceleration shall be determined in accordance to the formula in **B-3.1.2.1.2** and reported to the second digit after the decimal place ($a_{\text{wot test, κj}}$).

D-3 ANALYSIS METHOD 1: SLOPE-ASSESSMENT

D-3.1 Determination of the Anchor Point

The anchor point is the same for each gear ratio κ falling under the control range according to **D-2.3**. The parameters for the anchor point are taken from the acceleration test of Annex B as follows:

a) In the case the test has been carried out with two gear ratios:

   1) L_{anchor} is the higher sound pressure level of $L_{\text{wot(i)}}$ of left and right side of gear ratio i ; and
   2) n_{anchor} is the average of $n_{\text{BB, wot(i)}}$ of the 4 runs of gear ratio i reported from Annex B

b) In the case the test has been carried out in a single gear:

   1) L_{anchor} is the higher sound pressure level of L_{wot} of left and right side of gear ratio selected for the test; and
   2) n_{anchor} is the average of $n_{\text{BB, wot}}$ of the 4 runs of gear ratio selected for the test reported from Annex B

D-3.2 Slope of the Regression Line for Each Gear Ratio κ

The sound measurements shall be evaluated as function of engine speed according to **D-3.2.1**.

D-3.2.1 Calculation of the Slope of the Regression Line for Each Gear Ratio κ

The linear regression line is calculated using the anchor point and the four correlated additional measurements with the results for engine speeds and sound levels as reported under **D-2.5.2**.

$$Slope_{\kappa} = \frac{\sum_{j=1}^{5}\left(n_j - \overline{n}\right)\left(L_j - \overline{L}\right)}{\sum_{j=1}^{5}\left(n_j - \overline{n}\right)^2} \ (in\ dB(A)/1\,000/min)$$

with $\overline{L} = \frac{1}{5}\sum_{j=1}^{5} L_j$ and $\overline{n} = \frac{1}{5}\sum_{j=1}^{5} n_j$

where

n_{j} = Engine speed measured at line *BB'*

D-3.2.2 Slope of the Regression Line for Each Gear Ratio κ

The slope$_{\kappa}$ of a particular gear for the further calculation is the derived result of the calculation in **D-3.2.1** rounded to the first decimal place, but not higher than 5 dB(A)/1 000 min^{-1}.

In case of non-locked conditions, if slope$_{\kappa}$ < 0, the selected transmission setup is not valid. In that case the L_{urban} – Assessment as specified in **D-4** shall be applied.

D-3.3 Calculation of the Linear Sound Level Increase Expected for Each Measurement

The sound level $L_{ASEP,\text{κj}}$ for measurement point j and gear ratio κ shall be calculated using the engine speeds measured for each measurement point, using the slope specified in **D-3.2** to the specific anchor point for each gear ratio.

a) For $n_{\text{BB,κj}} \leq n_{\text{anchor}}$
   $L_{\text{ASEP ,κj}} = L_{\text{anchor}} + (\text{Slope}_{\kappa} - \text{Y}) \times (n_{\text{BB, κj}} - n_{\text{anchor}}) / 1\,000$

b) For $n_{BB,\kappa j} > n_{anchor}$
$L_{ASEP,\kappa j} = L_{anchor} + (Slope_{\kappa} + Y) \times (n_{BB,\kappa j} - n_{anchor})/1\,000$

where

Y= 1

D-3.4 Additional Samples

On request of the type approval authority, two additional runs within the boundary conditions according to **D-2.3** shall be carried out.

D-3.5 Specifications

D-3.5.1 Every individual sound measurement shall be evaluated.

D-3.5.2 The sound level of every specified measurement point shall not exceed the limits given below:

$L_{\kappa j} \leq L_{ASEP\_\kappa.j} + x$ with:

a) x = 3 dB(A) **+** limit value - L_{urban} for vehicle tested with non-locked transmission conditions (As applicable for the approved type of vehicle); and

b) x = 2 dB(A) + limit value - L_{urban} for vehicles tested with locked transmission conditions (As applicable for the approved type of vehicle).

D-3.5.3 If the measured sound level at a point exceeds the limit, two additional measurements at the same point shall be carried out to verify the measurement uncertainty. The vehicle is still in compliance with ASEP, if the average of the three valid measurements at this specific point fulfils the specification.

D-4 ANALYSIS METHOD 2: L_{urban} ASSESSMENT

D-4.1 General

This evaluation procedure is an alternative selected by the vehicle manufacturer to the procedure described in **D-3** and is applicable for all vehicle technologies. It is the responsibility of the vehicle manufacturer to determine the correct manner of testing. Unless otherwise specified, all testing and calculation shall be as specified in Annex B.

The measurement method is defined in **D-2**. Each testing point shall be evaluated individually.

D-4.2 Calculation of ΔL_{urban_ASEP}

D-4.2.1 *Data-Processing*

From any L_{wot_ASEP} as measured according to this annex, ΔL_{urban_ASEP} shall be calculated as follows:

a) Calculate a_{wot_ASEP} using acceleration calculation from **B-3.1.2.1.2.1** or **B-3.1.2.1.2.2** of Annex B to this standard, as applicable;

b) Determine the vehicle speed ($v_{BB'\_ASEP}$) at BB during the L_{wot_ASEP} test;

c) Calculate k_{P_ASEP} as follows:

$$k_{P\_ASEP} = 1 - (a_{urban}/a_{wot\_ASEP})$$

Test results where $a_{wot\ test\ \_ASEP}$ are less than a_{urban} shall be disregarded.

d) Calculate L_{urban} measured ASEP as follows:

$$L_{urban\_measured\_ASEP} = L_{wot\_ASEP} - k_{P\_ASEP} \times (L_{wot\_ASEP} - L_{crs\ rep})$$

For further calculation, use the L_{urban} from Annex B without rounding, including the digit after the decimal (xx.x).

e) Calculate $L_{urban\_normalized}$ to normalize the speed from $v_{BB'\_ASEP}$ to 50 km/h as follows:

$$L_{urban\_normalized} = L_{urban\_measured\_ASEP} - [0.15 \times (v_{BB'\_ASEP} - 50)]$$

f) Calculate the deviation ΔL_{urban_ASEP} relative to L_{urban} as follows:

$$\Delta L_{urban\_ASEP} = L_{urban\_normalized} - L_{urban}$$

D-4.2.2 *Specifications*

Compliance with limits: ΔL_{urban_ASEP} shall be less than or equal to 3.0 dB (A) + limit value - L_{urban} (As applicable for the approved type of vehicle).

D-5 REFERENCE SOUND ASSESSMENT (*see* the flowchart in fig. 14)

D-5.1 General

The reference sound can be obtained by simulation or from direct measurement. The result of one assessment method has to comply with the specification of **D-5.4**.

D-5.1.1 *Simulation Method*

For simulation, the reference sound is assessed at a single point in one discrete gear, simulating an acceleration condition assuming an exit speed $v_{BB'}$ equal to 61 km/h. The sound compliance is calculated using the slope results of **D-3.2.2**.

If the result of slope of **D-3.2.2** is not available for the gear specified in **D-5.2**, this slope of the missing gear can be determined according to **D-2.4**, **D-3.1** and **D-3.2**.

NOTE — Simulation may not always be applicable as the test result of Annex B and the elaborated slopes according to **D-3** might not provide consistent data for the simulation. In that case, it is recommended to carry out direct measurements.

D-5.1.2 *Direct Measurement Method*

For direct measurement, the reference sound is assessed at a single run in an acceleration condition started at line *AA'* as specified in **D-2.5**. The gear shall be as specified in **D-5.2** for vehicles tested in locked condition or in a gear selected position for normal driving as specified by the manufacturer for vehicles tested in non-locked condition.

The target test speed v_{AA} is equal to (50 ± 1) km/h unless v_{BB} exceeds 61 km/h.

If v_{BB} exceeds 61 km/h, the target test speed v_{BB} shall be set to (61 ± 1) km/h.

The entry speed shall be adjusted to achieve the target test speed.

D-5.2 The determination of gear α is as follows:

α = 3 for all manual transmission and for automatic transmission tested in locked position with up to 5 gears;

α = 4 for manual transmission and for automatic transmission tested in locked position with 6 or more gears. If the acceleration calculated from AA to BB + vehicle length in gear 4 exceeds 1.9 m/s², the first higher gear α > 4 with an acceleration lower than or equal to 1.9 m/s² shall be chosen.

For vehicles tested under non-locked condition, the gear ratio for further calculation shall be determined from the acceleration test result in Annex B using the reported engine speed and vehicle speed at line *BB'*.

D-5.3 Data-Processing for Simulation Assessment

D-5.3.1 *Determination of Reference Engine Speed* $n_{BB'}$ *ref α*

The reference engine speed, $n_{BB'\_ref}\ \alpha$, shall be calculated using the gear ratio of gear α at the reference speed of $v_{BB'\_ref}$ = 61 km/h.

D-5.3.2 *Calculation of* L_{ref}

$$L_{ref} = L_{anchor} + \text{Slope}\ \alpha \times (n_{BB'\_ref}\ \alpha - n_{anchor})/1\ 000$$

D-5.4 Specifications

D-5.4.1 For vehicles of category M1, L_{ref} shall be less than or equal to 76 dB(A).

D-5.4.2 For vehicles of category M1 fitted with a manual transmission having more than four forward gears and equipped with an engine developing a rated maximum net power greater than 140 kW (according to AIS 137-Part 5 and AIS 041) and having a maximum-power/maximum-mass ratio greater than 75, L_{ref} shall be less than or equal to 79 dB(A).

D-5.4.3 For vehicles of category M1 fitted with an automatic transmission having more than four forward gears and equipped with an engine developing a rated maximum net power greater than 140 kW (according to AIS 137-Part 5 and AIS 041) and having a maximum-power/maximum-mass ratio greater than 75, Lref shall be less than or equal to 78 dB(A).

For vehicles of category N1 with a technically permissible maximum laden mass below 2 000 kg, L_{ref} shall be less than or equal to 78 dB (A).

D-5.4.4 For vehicles of category N1 with a technically permissible maximum laden mass above 2 000 kg and below 3 500 kg, L_{ref} shall be less than or equal to 79 dB (A).

D-5.4.5 For vehicles of category M1 and N1 equipped with a compression-ignition and direct injection internal combustion engine, the sound level shall be increased by 1 dB(A).

D-5.4.6 For vehicles of category M1 and N1 designed for off-road use and with a technically permissible maximum laden mass above 2 tonnes, the sound level shall be increased by 1 dB(A) if they are equipped with an engine having a rated maximum net power of less than 150 kW (according to AIS-137-Part 5 and AIS-041) or by 2 dB(A) if they are equipped with an engine having a rate maximum net power of 150 kW (according to AIS-137-Part 5 and AIS-041) or higher.

D-5.5 Following statement of compliance with the additional sound emission provisions shall be provided by the manufacturer.

(Maximum format: A4 (210 x 297 mm))

.... (Name of manufacturer) attests that vehicles of this type (type with regard to its sound emission pursuant to this standard) comply with the requirements of **7.3.2.**

.... (Name of manufacturer) makes this statement in good faith, after having performed an appropriate evaluation of the sound emission performance of the vehicles.

Date: ....

Name of authorized representative: ....

Signature of authorized representative:

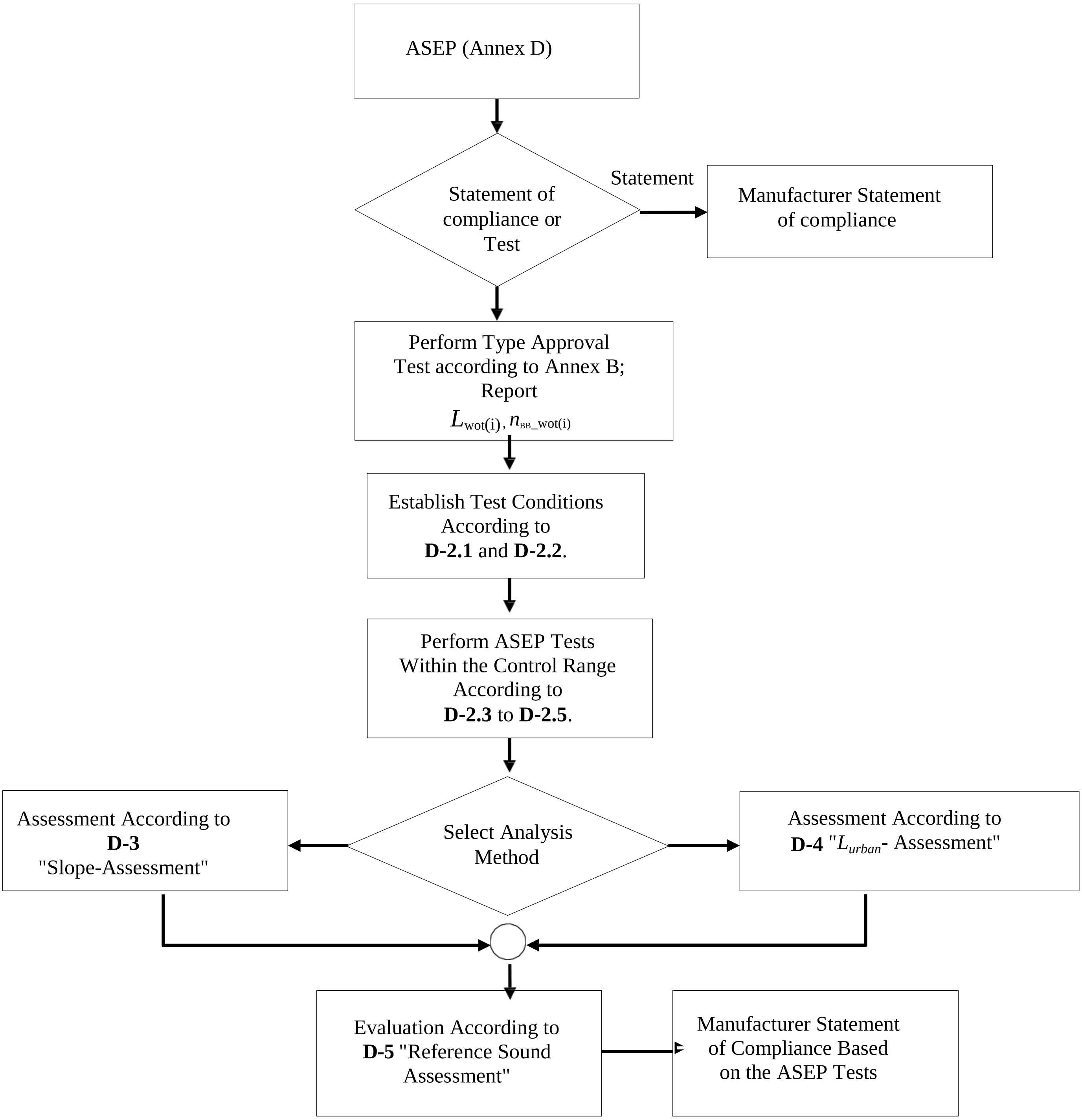

ASEP (Annex D)
Statement of compliance or Test
Statement
Manufacturer Statement of compliance
Perform Type Approval Test according to Annex B; Report $L_{\mathrm{wot(i)}}$, $n_{\mathrm{BB\_wot(i)}}$
Establish Test Conditions According to D-2.1 and D-2.2.
Perform ASEP Tests Within the Control Range According to D-2.3 to D-2.5.
Select Analysis Method
Assessment According to D-3 "Slope-Assessment"
Assessment According to D-4 "L_{urban}- Assessment"
Evaluation According to D-5 "Reference Sound Assessment"
Manufacturer Statement of Compliance Based on the ASEP Tests

FIG . 13 FLOWCHART FOR THE ASSESSMENT CONCEPT FOR ASEP ACCORDING TO ANNEX D

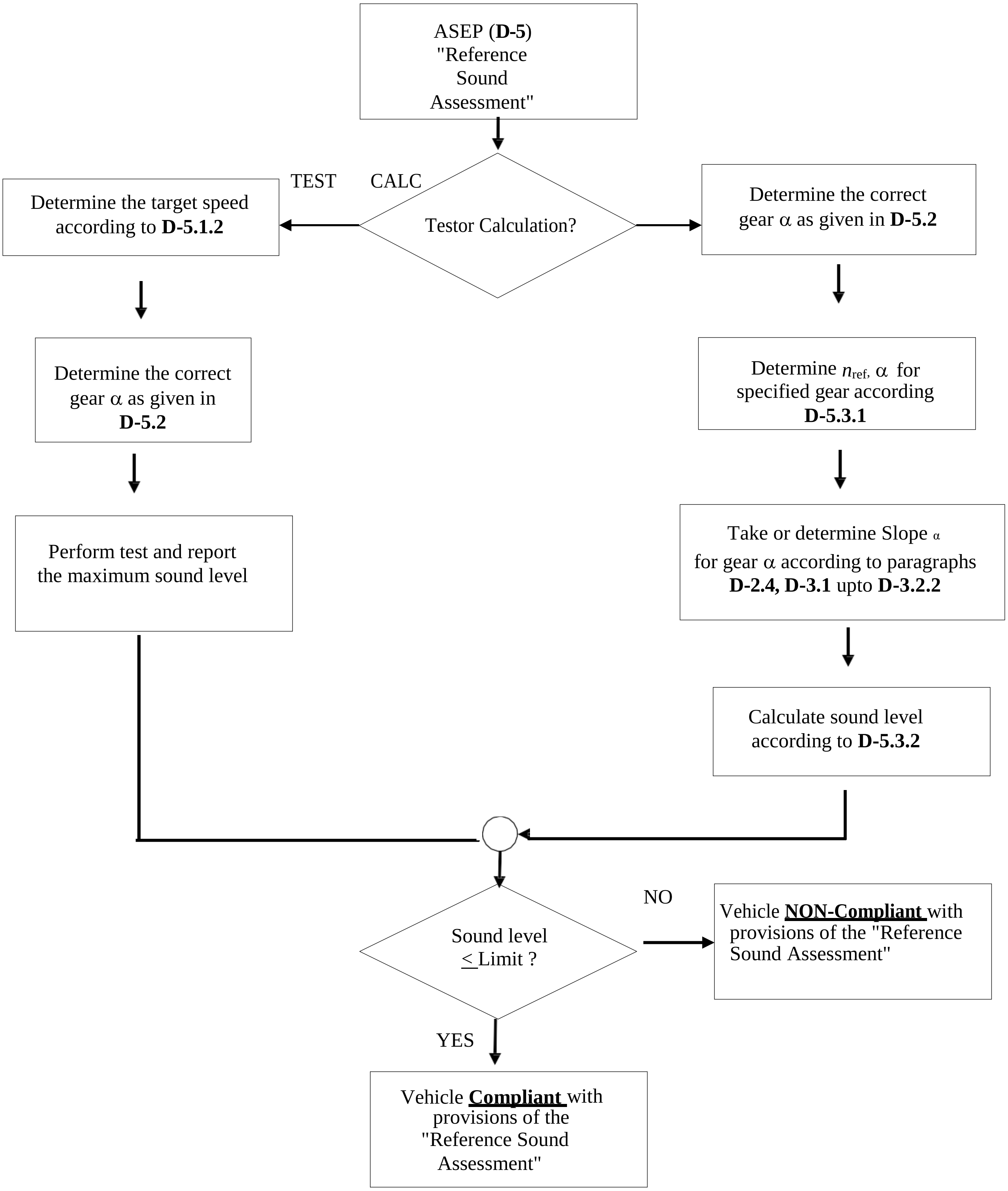

ASEP (D-5) "Reference Sound Assessment"
TEST
CALC
Testor Calculation?
Determine the target speed according to D-5.1.2
Determine the correct gear α as given in D-5.2
Determine the correct gear α as given in D-5.2
Determine n_{ref}, α for specified gear according D-5.3.1
Perform test and report the maximum sound level
Take or determine Slope α for gear α according to paragraphs D-2.4, D-3.1 upto D-3.2.2
Calculate sound level according to D-5.3.2
NO
Sound level ≤ Limit ?
Vehicle NON-Compliant with provisions of the "Reference Sound Assessment"
YES
Vehicle Compliant with provisions of the "Reference Sound Assessment"

FIG. 14 FLOWCHART FOR THE VEHICLE SOUND ASSESSMENT ACCORDING TO **D-5**. 'REFERENCE SOUND ASSESSMENT'

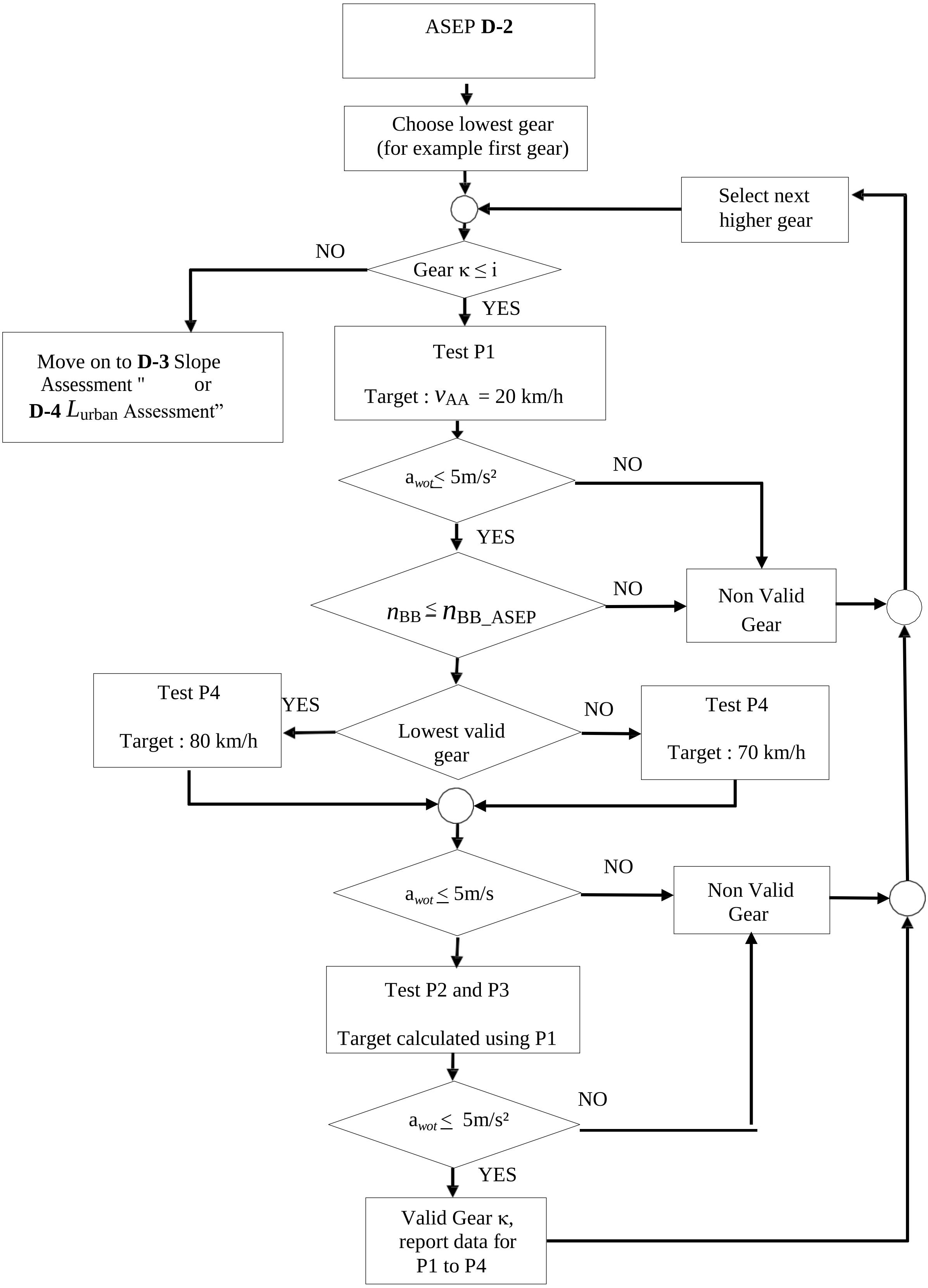


FIG. 15 FLOWCHART FOR THE DETERMINATION OF THE INDIVIDUAL TEST POINTS P_J ACCORDING TO **D-2** 'MEASUREMENT METHOD'

ANNEX E

(*Clauses* 6.1.1 *and* 7.2.1.1)

INDOOR TESTING

E-1 DOCUMENTATION FOR INDOOR APPLICATION

E-1.1 Documentation for indoor application shall include:

a) Validation of facility, for example free field propagation, dyno and air handling background noise level, dyno dynamic performance, software;

b) Procedures to be applied for indoor testing, for example, dyno and software set-up, loading and tie-down, air-handling and vehicle's temperature management;

c) Coast down and tyre sound level data used for calculation of dynamometer load coefficients and tyre sound data used for determination of final reported results; and

d) Test results on a representative selection of the manufacturer's production to demonstrate that indoor testing delivers comparable results as outdoor testing within acceptable accuracy.

E-2 VEHICLE TESTED INDOOR USING VARIANT A

Indoor pass-by test is simulated by measurement of power train sound on the dynamometer and energetical addition of the tyre/road sound (measured separately on an outdoor test track).

E-2.1 General

This method is a combination of indoor testing (power train sound) and outdoor testing (tyre/road sound). It is not necessary to repeat the measurement of the tyre/road sound every time a vehicle is tested. The data of several tyres can be stored in a database and a matching data set from the database can then be used for the test.

E-2.2 Power Train Sound

It shall be ensured that there is no remaining tyre/road sound affecting the measurements. In any case it shall be ensured that the remaining tyre/road sound shall be at least 10 dB below the maximum A-weighted sound pressure level produced by the vehicle under test. If this condition cannot be fulfilled, a correction shall be carried out. This correction procedure is described in **B-6** of ISO 362-3 : 2016.

The vehicle shall be measured according to the operating condition specified in **B-3.1.2.1** or **B-3.1.2.2**.

E-2.3 TYRE/ROAD SOUND

The measurements of the tyre/road sound shall be performed on a test track as described **B-2.1.1**. The evaluation of tyre/road sound consists of two procedures, namely:

a) Evaluation of free rolling sound; and

b) Evaluation of tyre/road sound including torque influence which can be derived from by a simplified method.

All conditions for evaluation of tyre/road sound shall be done according to **B-3**.

E-2.4 CALCULATION OF THE TOTAL VEHICLE SOUND

The total vehicle sound is the energetical sum of tyre/road sound and power train sound. This calculation shall be carried out for each single run as describe in **10.2.4** of ISO 362-3 : 2016.

E-3 PROCEDURE FOR MEASUREMENT, EVALUATION, AND CALCULATION OF TYRE/ROAD SOUND WHEN USING VARIANT 'A'

All conditions for evaluation of tyre/road sound, free rolling sound, and torque influence are described in Annex B of ISO 362-3 : 2016.

E-4 ADJUSTMENT OF ROOM DIMENSIONS

To cater for the smaller size test rooms, the maximum levels shall be evaluated with caution though to avoid missing them according to Annex E of ISO 362- 3: 2016.

ANNEX F

(*Clause* 7.2.1.1)

COMPRESSED AIR NOISE

F-1 METHOD OF MEASUREMENT

The measurement is performed at microphone positions 2 and 6 according to Fig. 1, with the vehicle stationary. The highest A-weighted sound level is registered during venting the pressure regulator and during ventilating after the use of both the service and parking brakes.

The noise during venting the pressure regulator is measured with the engine at idling speed. The ventilating noise is registered while operating the service and parking brakes; before each measurement, the air-compressor unit has to be brought up to the highest permissible operating pressure, and then the engine switched off.

F-2 EVALUATION OF THE RESULTS

For all microphone positions two measurements are taken. In order to compensate for inaccuracies of the measuring equipment, the meter reading is reduced by 1 dB(A), and the reduced value is taken as the result of measurement. The results are taken as valid if the difference between the measurements at one microphone position does not exceed 2 dB(A). The highest value measured is taken as the result. If this value exceeds the sound limit by 1 dB(A), two additional measurements are to be taken at the corresponding microphone position.

In this case, three out of the four results of measurement obtained at this position have to comply with the sound limit.

F-3 LIMITING VALUE

The sound level shall not exceed the limit of 72 dB(A).

The measurement is performed at the stationary vehicle according to Fig. 16, using two microphone positions at a distance of 7 m from the contour of the vehicles, and at 1.2 m above ground.

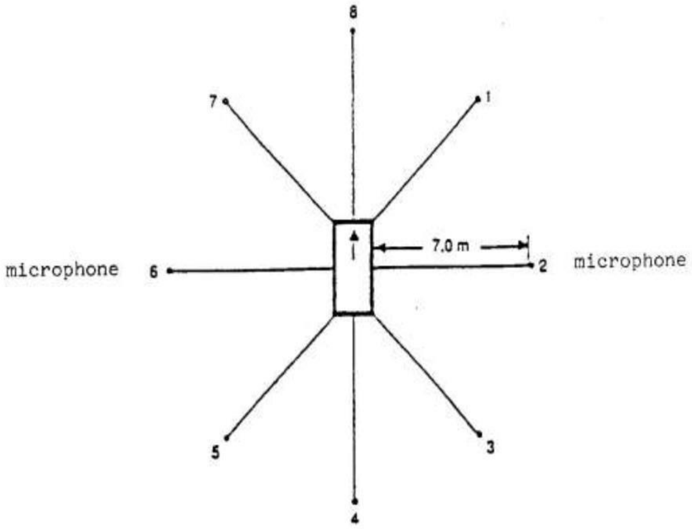


FIG. 16 MICROPHONE POSITIONS FOR MEASUREMENT OF COMPRESSES AIR NOISE

ANNEX G

(*Clause* 6.1.1)

Table 6 Guidline for Deciding for Testing in Case of Modification Made in Already Type Approved Vehicle

Sl No.	Modification made in vehicle	Testing to be Done or Not
(1)	(2)	(3)
i)	Engine Type, Capacity, Number and arrangement of cylinder	To be tested
ii)	Change in maximum power	To be tested, if the power is increased in excess of 5 percent.
iii)	Approach speed for test at AA’, due to change in parameter such as: Engine rpm at peak power, maximum governed rpm	To be tested, in case of decrease in excess of 5 percent
iv)	**Intake System**	
	Air Filter Type	To be tested in case of any change
	Fuel System – Carburetor to FI or Vice versa	To be tested in case of any change
	Turbocharger, supercharger	To be tested in case of inclusion and deletion.
v)	Change in Exhaust system such as design of silencer, exhaust tube Internal Diameter, Tail pipe Internal Diameter and location	To be tested in case of any change in design.
vi)	Type of transmission	To be tested in case of any change.
vii)	Transmission Ratio	If the engine rpm at line *BB*’ is affected such that the gear in which test is conducted is not same.
viii)	Tyre	To be tested if diameter is reduced. To be tested if change is from cross ply to radial ply.

ANNEX H
(*Foreword*)

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This Indian Standard has been developed from Doc No.: TED 04 (13068).

Amendments Issued Since Publication

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Published by BIS, New Delhi